DOCUMENT RESUME

ED 263 727 EC 180 998

AUTHOR	Lang, Theresa Aherne; And Others
TITLE	Working Papers in Speech-Language Pathology and Audiology. Volume XIII.
INSTITUTION	City Univ. of New York, Flushing, N.Y. Queens Coll.
PUB DATE	85
NOTE	117p.; For Volume XII, see ED 252 047.
PUB TYPE	Reports - Research/Technical (143) -- Collected Works - General (020)
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	*Audiology; *Audiometric Tests; Autism; Clinical Diagnosis; *Communication Disorders; Elementary Education; *Hearing Aids; Hearing Impairments; *Language Acquisition; Preschool Education; *Speech Therapy; Young Adults; Young Children

ABSTRACT

Six papers contributed by graduate students report on studies that focused on the application of theory to practice in speech-language pathology and audiology. The first study revealed the ability of an autistic child to adapt to conversational partners of various ages and linguistic abilities. In the second paper, a language impaired child's communicative interactions were studied in the clinic and the home, and home samples yielded the highest mean length of utterances and the greatest total output of language. In the third study, five hearing impaired adults demonstrated the effectiveness of the Hearing Performance Inventory in measuring changes after amplification. The fourth study explored, via brain stem evoked response audiometry, the frequency of interear asymmetries occurring in peak latency and amplitudes in 15 normal hearing Ss. Also concerning auditory brain stem response (ABR), the fifth study found that head size is a factor to be considered in using ABR to make a differential diagnosis. The final study devised a comprehension task within a naturalistic context to test the ability of preschoolers to understand synthetic speech. (CL)

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1937

WORKING PAPERS
IN
SPEECH-LANGUAGE PATHOLOGY
AND
AUDIOLOGY

Speech and Hearing Center
Department of Communication Arts and Sciences
Queens College of the City University of New York

VOLUME XIII 1985

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(TEMPORARY NUMBER: 718-670-4222)

August, 1985

This is the thirteenth volume of studies completed by our graduate students as part of their Master of Arts degree. The students have been supervised by the faculty.

We are particularly pleased with the continued application of current theoretical principles to the clinical process. As a result, course work and clinical experience are unified. Each client presents questions to be answered within an experimental framework. In this process theory is continually tested and re-examined to meet the reality of the human-professional experiences. We believe that this learning process will ultimately extend effectiveness in treatment.

Throughout the graduate program the students have maintained a scholarly sense of their studies. More important, the faculty has guided the students with knowledge, enthusiasm and a rare degree of sensitivity.

Robert Rosenbaum
Joel Stark

Contents

Autism: Variations in Communicative Style.
Theresa Aherne Lang, Elaine Geller..............................1

The Effect of Contextual Variation on Language Sampling.
Suzanne M. Byrne, Amy Mittler, Sima Gerber Wollner............29

The Hearing Performance Inventory as a Tool for Assessing Hearing Aid Benefit.
Susan A. Deitch, James J. Dempsey.............................51

Asymmetry in the Latency-Intensity and Amplitude-Intensity Functions of the Brain Stem Evoked Responses of Normal Hearing Subjects.
Sharon Ripinsky, Lynn Spivak..................................61

The Effect of Head Size on the Auditory Brainstem Response.
Elaine Censoprano, James J. Dempsey...........................74

The Effect of Context on Preschool Children's Understanding of Synthetic Speech - A Pilot Study.
Lucille Punzi, Arlene Kraat...................................84

Content of the first twelve volumes...........................107

Autism: Variations in Communicative Style

Theresa Aherne Lang

Elaine Geller*

Abstract

The purpose of this study was to investigate the ability of an autistic child to adapt to conversationaal partners of various ages and linguistic abilities. The subject was observed in dyadic interactions with a familiar adult, peers, and a toddler in topic-controlled and spontaneous conversational contexts. Various linguistic and pragmatic behaviors were analyzed. Results indicated that the autistic child varied his linguistic and communicative style in response to different conversational partners and social contexts. These included mean length of utterance, speech act type selection, frequency of talk, echolalia, intelligibility and non-verbal behaviors. Implications for language training are discussed.

The recent interest in pragmatics has broadened the framework in which language is viewed (Bates, 1976; Prutting, 1982). Emerging from a pragmatic perspective is the notion that communicative competence involves the interface between cognitive, linguistic, and social knowledge of the world (Bates, 1976). Whereas earlier research in language development focused upon the form of language, the more current research has examined language use in context. This broader perspective has lead to research interests in areas such as speech acts, presuppositional skills, conversational skills and stylistic variation in response to different conversational partners and social contexts.

As a result of the increased interest in the study of communication, different theoretical perspectives have emerged about the social (or communication) abilities of young normal children. The current theme in the child language research is that young normal children are very communicative from their earliest development. It has been shown that preschool-aged children display a variety of communication skills including turn-taking, topic collaboration and strategies for repairing utterances during communication breakdowns (Gallagher, 1977; Rees 1982). Further, various researchers have demonstrated that young normal children make stylistic variations in their language based on their conversational partner and the social situation (Gleason, 1973; Sachs and Devin, 1973; Shatz and Gelman, 1973). These researchers have demonstrated that normal children are aware of and responsive to subtle partner characteristics such as age and/or language level and modify their language and communication style accordingly.

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The description of young normal children as being social and communicative is in direct contrast to the early Piagetian notion of egocentricity (1926). According to Piaget, young children are egocentric in their use of language and unable to consider perspectives other than their own until approximately seven years of age. In contrast, recent researchers have demonstrated sociocentricity from very early on (Bruner, 1975). Further, the recent studies in speech style variation have shown that young normal children are indeed sociocentric in their use of language and that they are able to take into account their partners' presumed or actual needs.

In a study of natural family interaction in children from infancy through eight years of age, Gleason (1973) found that by eight years of age normal children had three distinct styles of speaking: one to adults, one to peers and one to babies. Among the stylistic variations that Gleason observed was the choice of speaking or not to certain partners. The children frequently whined when speaking to parents. In contrast these children used a more narrative style and more politeness conventions in speech directed to unfamiliar adults. In terms of age-related stylistic variations, the older children (5-8 years of age) used "baby-talk" in speaking to younger children. This "baby-talk" style was characterized by shorter utterances with more concrete nouns, the use of diminutives and varied terms of endearment (e.g., "honey"). By eight years of age the children were also observed to use a "socializing style" in speech to younger children whereby they told them what to do, what to think and how to feel. In general, speech directed to peers contained a greater number of exact repetitions of the other children's utterances as well as sound effects and expressives (e.g. yuck!). In sum, Gleason hypothesized that children's knowledge of stylistic variation is acquired by observing adults interact with different aged partners.

In a similar study, Shatz and Gelman (1973) investigated stylistic variation in a group of four-year old normal children and found that the form, content, and use of the children's language varied across conversational partners. The researchers observed their subjects in dyadic interactions with three partners: their mothers, chronologically aged-matched peers and two year old toddlers. Two observational contexts were utilized. These inclued a topic controlled (or "toy-task") context and a spontaneous conversational (or "free-play") context. Results of the study revealed that the four year olds used shorter, less complex utterances and more concrete verbs when talking to the two-year-olds. Additionally, an increase in the number of attentional utterances (e.g., look) was observed with these partners. Speech directed to adults and peers was similar in style. It was characterized by longer, more complex utterances and a decreased use of attentional utterances. Shatz and Gelman suggested that the four-year-old children used direct listener feedback to formulate messages that were appropriate for their listeners.

Sachs and Devin (1973) have suggested that listener feedback is not always necessary for speech style variation to occur. These researchers observed four children (3.9-5.5 years) in spontaneous play interactions with adults (their mothers), chronologically aged-matched peers and younger children (age 1.2-3.5 years). In addition, the subjects were studied as they talked to a baby doll who they were told was "just learning how to talk" and when role-playing a baby "just learning how to talk". The findings for talk to adults, peers and younger children resembled the finding of Shatz and Gelman (1973). The authors suggested that the young children knew an appropriate speech style for babies which was not dependent upon listener feedback.

The above studies have shown that young normal children are sensitive to the age and/or language level of their conversational partners. This literature demonstrates that young normal children do possess the ability to consider the perspective of their conversational partners and can modify their messages accordingly. These behavior occur at a time when children are supposedly unable to consider perspectives other than their own (Piaget, 1926).

Speech style variation has also been investigated in language - impaired children. Fey, Leonard and Wilcox (1981) studied children with specific language impairment ranging in age from 4.6 - 6.5 years. The subjects were observed in dyadic play interactions with: (a) normal children matched according to chronological age and (b) normal children matched by linguistic level based on mean length of utterance (M.L.U.). The M.L.U.'s of all subjects exceeded 3.0 morphemes. Fey et al. found that the language - disordered children used a lower pre-verb length (a measure of linguistic complexity), less back-channel response (a measure of conversational assertiveness) and a greater number of internal state questions (a semantic measure) in speech to the younger children of similar language levels. Contrary to the authors expectations, the language - impaired subjects did not display partner - related differences on the remaining dependent measures: M.L.U. external world questions, attentional utterances, self repetitions and imperatives. Thus, the stylistic variations that occurred were described as "less extensive" than those reported in studies of young normal children (such as Sachs and Devin, 1973; Shatz and Gelman, 1973).

Fey et al.(1981) noted several differences in their experimental design, as compared to other research designs, which may have accounted for their findings. First, in the Fey et al. study, the younger normal partners were chronologically older and probably more linguistically sophisticated than the normal children in the normal developmental studies. Second, there were no adult listeners which would have maximized the variation(s) observed in speech style. Nevertheless, the language-impaired children made systematic changes in the form, content and use of their language as a function of the age and/or linguistic level of their partners. Thus, children with specific language impairment demonstrated an awareness of an ability to adapt to different conversational partners, though to a lesser degree than young normal children.

In a follow-up study, Fey and Leonard (1984) investigated stylistic variation in children with specific language impairment (ages 4.7 - 6.2 years); and younger children of similar linguistic level. Each of these groups of children was observed in dyadic interactions with three conversational partners: the mother, a chronological age-matched peer and a toddler (1.7 - 2.4 years). Results indicated that the children with specific language impairment (SLI) modified their language in a similar manner to the chronologically-age-matched subjects. For example, the SLI children were more conversationally assertive and used a greater number of self-repetitions, imperatives and questions in speech to younger children, as did the same aged normal subjects. However, the SLI child did not modify MLU, mean per-verb length or use of internal state questions as did the same-aged chidren. The authors noted that the SLI children were at times more proficient at adapting speech style than the younger normal subjects. For example, the SLI subjects used a greater proportion of imperatives and self-repetitions with their toddler partners; however, the young normal subjects displayed no significant differences in these measures across conversational partners. Thus, these researchers have demonstrated that this subgroup of language-impaired children displayed an awareness of and ability to adapt to the age and/or language level of their conversational partners.

For other subgroups of language-impaired children, the recent trend in pragmatics has lec to a renewed interest in the language and communication abilities of autistic children. Recent studies in autism have explored autistic children's use of language in social contexts and have found that these children exhibit varying degrees of communicative skill.

Traditionally, autistic children have been described as being profoundly withdrawn and unable to relate to people and the environment in appropriate ways (Kanner, 1943). Researchers have consistently reported atypical social-interpersonal behaviors in these children such as decreased eye-contact, decreased use of non-verbal gestures and a lack of social responsiveness (Baltaxe and Simmons, 1975; Fay and Schuler, 1980). The language of verbal autistic children has been described in terms of structural features such as echolalia, methaphoric substitutions, literalness, affirmation by repetition and pronominal reversal. Until recently, autistic language has not been looked in terms of its communicative features.

In terms of the characteristic features of autistic language, Yudkovitz, Lewinson and Rottersman (1975) have noted several communicative deficits in psychotic children. The first of these involves inadequate attention to "listener feedback". This inability to take into account the needs of one's communicative partner results in a lack of responsiveness to the other partner's conversational bids. Second, Yudkovitz et al. noted that psychotic children exhibit deficits in introducing and changing topics which again may result from the children's failure tc assess the needs of their partners. The authors suggested that these atypical communication behaviors resemble what Piaget referred to as egocentric use of language. Similarly Greenlee (1981) described the language of one psychotic child as being egocentric in nature. Greenlee noted that the psychotic child demonstrated "a disregard for his listener which is quite distinct from the normal pattern of development" (p. 83).

Looking at autistic children's language within a pragmatic framework reveals a somewhat different profile of some of the language and communicative abilities of these children. For example, traditionally, echolalia has been defined as "meaningless repetition of a word or word group just spoken by another person" (Fay and Schuler, 1980, p. 25). Recent research has shown that echolalia can serve a range of communicative as well as non-communicative functions for autistic children (Prizant and Duchan, 1981). Thus, when echolalia was studied in naturalistic contexts using in-depth pragmatic analyses, it was found to serve a range of communicative intentions for the autistic child.

Although autistic children exhibit significant communicative deficits (Fay and Schuler, 1980; Snyder, 1982) closer analysis of their communicative style reveals varying degrees of communication ability. For example, Bernard-Opitz (1982) noted that the communicative performance of an eight-year-old autistic child varied in response to his conversational partner and the social context. This autistic child was observed in dyadic interactions with his mother and a stranger in interactional and non-interactional (i.e., "waiting") conditions, as well as in a conversational condition with his clinician. Results indicated that a greater number of utterances were produced in interactional conditions than in the non-interactional conditions. In terms of partner-related variations, the autistic child produced the greatest number of communicative and intelligible utterances with the clinician, and the least number of communicative utterances with the stranger. The child used a greater number of requests with his mother than with the clinician. In contrast, the child used more statements with the clinician than with his mother. The child introduced new topics frequently with the clinician but rarely with other partners. Verbal output was quite limited with the stranger. The author concluded that this autistic child showed a definite awareness of different communicative partners. This contradicts previous generalizations that described autistic children as being socially unresponsive to others.

Teitelbaum and Wollner (1982) investigated the verbal output and communicative style of an autistic child with different partners who had different interactive styles. This child (who is also the subject of the present study) was observed in naturalistic play interactions with his mother, clinician and teacher in settings representative of his daily environment. It was found that the child's mean length of utterance varied across partners and was the greatest with the clinician who adopted a non-directive interactive style. In terms of language function, the child used many comments and requests, and few responses with the clinician. In contrast, the child primarily used responses with his mother and teacher. These two partners tended to request frequently. In conversation, the child initiated and extended topics (by adding new information) most frequently with the clinician. In contrast, the child extended topics through the use of responses with his mother and his teacher. The mother and teacher tended to dominate

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the conversational exchanges by initiating the topics of discourse. Thus, this autistic child was observed to vary his communicative style and linguistic output as a function of partner characteristics.

The findings of these recent studies such as Bernard-Opitz, (1982) suggest that despite the generally accepted notion that autistic children demonstrate degrees of awareness and responsiveness to their communicative partners and consequently, they alter their communicative behavior and linguistic output based on their partner characteristics. These findings have important implications for the present study. If autistic children exhibit varying degrees of communicative ability, then we would expect to see some awareness of and responsivity to different partners of various ages and/or linguistic abilities. In light of the recent pragmatic studies cited above, the question of interest here is whether or not autistic children are able to adapt their language and communicative style in response to partner characteristics of age and language level.

The present study investigated an autistic child's ability to adapt to conversational partners of different ages and language levels. These partners included a familiar adult (his mother), peers and a toddler. The autistic child was observed in dyadic interactions with each partner during spontaneous conversational (or "free play") contexts and during controlled (or "toy-task") contexts. The investigators were interested in exploring the autistic child's linguistic and pragmatic variations with different conversational partners.

Method

Subjects

The subject, D., is an 11.6 year old autistic and language-impaired male child. D. exhibits a range of behaviors characteristic of autism (Baltaxe and Simmons, 1975) which include severe speech and language delays, echolalia, stereotypic utterances, disturbed speech rate and prosody, ritualistic and stereotypic play, poor eye-gaze, and verbal cognitive deficits.

D. has been receiving speech and language therapy at the Queens College Speech and Hearing Center since September 1976 at which time his ability to interact with people and the environment was minimal. D. has demonstrated significant progress over the course of treatment. In terms of semantic-syntactic abilities, D. encodes all early occurring semantic relations. D. has difficulty expressing later developing semantic notions such as causality, antithesis, time, etc. D.'s mean length of utterance at the onset of the study was 4.2 morphemes.

In terms of communication skills, D. expresses restricted a range of communicative intentions for a child of his linguistic level. D. uses language to label , to comment, to request actions/objects and to respond to questions. D. uses language less frequently to greet, to request information, to request clarification and to express feelings and attitudes. D. continues to present marked deficits in the ability to initiate and maintain conversational exchanges. Similarly, D. dysplays decreased sensitivity to the needs of his partner in discourse.

The conversational partners in the study were as follows:

1. Familiar adult (MOTHER partner)

2. Normal chronologically age-matched "peer" (CA partner)_

3. Language-impaired, linguistically-matched "peer" (MLU partner)

4. Young normal child (TODDLER partner)

These partners were chosen to represent a range of ages and varied levels of linguistic ability. The oldest and most "sophisticated" partner was the familiar adult partner (the subject's mother). The youngest and least "sophisticated" partner was a normal 2.4 year old female toddler. The toddler's MLU was 2.2 morphemes. Two "peers" were chosen for this study, one child was matched to the subject's chronological age (11.3 years of age). This child was also considered to be a more "sophisticated" communication partner. The second child was a language-impaired child of the same linguistic level as the subject (based upon MLU). This language-impaired partner, K., was 5.1 years and had an MLU of 3.7 morphemes. K. exhibited deficits in expressive language abilities which included a limited semantic - syntactic repertoire, morpho - syntactic errors, a limited lexicon, phonological simplifications, a restricted range of communicative intentions and impaired conversational skills. Informal assessment of both the subject and the language-impaired partner revealed similar comprehension skills which included the ability to carry out 2-3 step directives and respond to a variety of wh-question forms.

Apparatus

This study was conducted in a 10′ x 12′ room at the Queens College Speech and Hearing Center. The subject and each conversational partner engaged in dyadic interactions on the floor of the therapy room. The experimenter was present in the room during all sessions and a second experimenter operatec a Sony HVC 2200 video camera and SL340 deck from just outside of the room. Each observational session was videotaped and subsequently transcribed by one experimenter. The pre-training sessions were audiotaped and scored according to specific criteria which will be discussed subsequently. Similarly, the language samples obtained prior to the onset of the observational sessions were also audiotaped and transcribed by one experimenter.

Stimulus materials for the study consisted of a large variety of toys (see appendix A). The pool of toys for the free-play context included: colorforms, legos, playdoh, kitchen apparatus and a toy house with related objects and people. The toys for the toy-task context were a Child Guidance Pumpkin Farm and a Playschool Lift and Loading Dock. These two toys were selected to meet the following criteria established by Shatz and Gelman (1973) and included: (1) sufficient parts for both subject and partner to manipulate toy items simultaneously; (2)sufficient interest for both subject and partner; and (3) being novel to subject and partner, yet not requiring extensive instruction as to their use.

Procedure

Criteria to establish linguistic level. Prior to the onset of the study, a language sample was obtained from the subject, the toddler, and the linguistically-matched (language impaired) child. Mean length of utterance was calculated for each child using Brown's (1973) procedure. A minimum of 50 utterances were obtained from each child. The language samples were obtained while one experimenter engaged the child in spontaneous free play activities with a variety of toys. Each of the language samples was audiotaped and transcribed by one experimenter. They were collected over a three week period.

Pre-training. In order for the subject to perform the toy-task context of the study, a pre-training procedure was used to insure that he could appropriately manipulate and talk about the toys. At the onset of each pre-training session, one experimenter demonstrated the appropriate use of one of the toys. Next, the subject was instructed to imitate appropriate play with the toy. These two steps were repeated if the subject could not appropriately manipulate the various toy items. The experimenter then assessed the subject's lexical comprehension and production of the individual toy items. The subject was taught the labels for those objects he did not know. Finally, the subject was instructed to "teach" the second experimenter how to use the toy, such that she could also play appropriately with the toy.

The two toys to be used in the experiment were alternately presented for each pre-training session. The pre-training period consisted of four twenty minute sessions over a two week period. Thus the child had the opportunity to play with each toy twice. The pre-training period was considered complete when the subject could manipulate the toys appropriately, discriminate and label the individual toy items/objects (with 80% accuracy), and demonstrate appropriate use of each toy verbally and/or non-verbally to one of the experimenters.

Reinforcement during pre-training consisted of a token exchange system. A token was given for appropriate verbal and/or non-verbal responses (e.g., labeling an object; manipulating an object appropriately; showing and/or telling another person how to play with the toy). The tokens were exchanged for a play period with a toy of the subject's choice. This form of reinforcement had been demonstrated to be effective with the subject in prior therapy sessions.

Observational sessions. The subject interacted with each partner on two separate occasions. Thus, there were eight observational sessions conducted over a four week period. (See Appendix B for a summary of the order of occurrence of conversational partners and contexts). Two observational sessions were conducted weekly. During sessions I-IV, the subject interacted with the partners in the following order:

a. MOTHER
b. TODDLER
c. Linguistic level-matched child (MLU)
d. Chronological age-matched child (CA)

The order was reversed during sessions V-VIII.

During each session, the subject was observed in two different contexts with each partner. These contexts included a structured, topic - controlled ("toy-task") context and an unstructured spontaneous conversational ("free-play") context. The free-play context preceded the toy-task context during sessions I-IV. This order was reversed for sessions V-VIII. Each context was presented for nine to ten minutes.

Free-Play Context At the onset of the free-play context, the subject and his partner were introduced by the experimenter and told that they were going to play together. Then they were presented with a pool of toys and instructed to play with whatever they wanted. They were given a two minute warm-up period which was excluded from the data analysis. This was followed by a ten minute period of uninterrupted play.

Toy-Task Context At the onset of the toy-task context, the subject was presented with one of the two toys chosen for this context. Next, the subject was informed that his partner had never played with the particular toy before. He was then instructed to demonstrate and explain to his partner how to use the toy. The experimenter emphasized that the subject's responsibility to make sure that his partner understood how to use the toy. Similarly the experimenter emphasized that the subject was to explain and not simply demonstrate how to use the toy, so that the partner could play appropriately with the toy. Specifically the subject was instructed as follows:

> "____________ (name of partner) never played with this toy before. He doesn't know how to play with this. You teach him how to play with it. You help him so he can play with it too. Show him what to do and say it to him. Remember, you have to talk and not just show him what to do."

In addition, the partner was instructed to watch and listen to the subject who was going to show/tell him how to play with the toy. If no interactions occurred between the subject and partner following these instructions, the experimenter reminded the subject to teach his partner how to use the toy. Additional prompting was done as required throughout the toy-task contexts. These contexts were terminated when the children ceased to play with the toys or, when ten minutes had elapsed. The subject "taught" one of two pre-selected toys during each session. Each partner played with each of the two toys only once.

Results

Our first interest was to explore variations in the linguistic complexity of D.'s utterances with each conversational partner. Mean length of utterance (M.L.U.) was calculated according to Brown's system (1973). Incomplete utterances, unintelligible and partially unintelligible utterances, as well as utterances containing jargon and sound effects were excluded from the linguistic analysis. Table 2 illustrates D.'s M.L.U. with each conversational partner in the combined toy-task and free-play contexts. The number of utterances used to determine the M.L.U. varied across conversational partners and context type.

Table 1. Mean Length of Utterance (MLU)

Partner	Average MLU	MLU in Free-Play Contexts	MLU in Toy-Task Contexts
MOTHER	3.55 (306)*	3.5 (189)	3.6 (117)
CA	3.15 (125)	2.7 (57)	3.6 (68)
MLU	3.45 (66)	3.7 (14)	3.2 (52)
TODDLER	2.45 (116)	1.9 (65)	3.0 (51)

(*The number of utterances included in calculating MLU is found in parentheses).

As can be seen, D.'s MLU varied across conversational partners and contexts. In terms of conversational partners, D.'s MLU was greatest with his MOTHER as compared to all other partners. With the MLU partner, D.'s MLU was also high in both contexts although it was based upon a very limited number of utterances. With the CA partner, D.'s MLU was greater in the toy-task contexts as opposed to the free-play contexts. Nevertheless, his overall average MLU was less with this partner than with his MOTHER or the MLU partner. The most marked differences in MLU were evident in looking at D.'s interactions with the TODDLER. During free-play, D.'s MLU decreased to 3.0 morphemes during the toy-task contexts. Nevertheless, it is interesting to note that D.'s average MLU was the lowest with the TODDLER in both contexts as compared to his MLU with the other conversational partners.

The linguistic complexity of D.'s utterances was also measured in terms of the use of simple and complex sentences. Complex sentences were defined as those sentences containing connective forms (such as; conjunctions, relative pronouns, and wh-adverbs) and/or expressing inter-event and intra-event meaning relations (Bloom, Lahey, Hood Lifter and Fiess, 1980). In contrast, simple sentences expressed only one event and/or did not contain connective forms. Table 3 summarizes the linguistic complexity of D's utterances across partners and contexts.

Table 2. Number of Simple and Complex Sentences.

	Free-Play Context			Toy-Task Context		
Partner	Simple	Complex	Other*	Simple	Complex	Other*
MOTHER	187	2	48	111	6	22
CA	57	0	44	67	1	27
MLU	14	0	40	52	0	49
TODDLER	65	0	51	50	1	19

(*Other category consists of utterances excluded from linguistic analysis, i.e., jargon, incomplete utterances, partially or fully unintelligible utterances)

The corpus of D.'s complex utterances consisted of utterances encoding additive (coordinate) and causal semantic relations marked by the connective and, so, or because. As can be seen, D. used several complex sentences (8) during interactions with his MOTHER. In contrast, D. rarely used complex sentences (a total of 2) with the other conversational partners. In general, D.'s overall use of complex linguistic forms was minimal in these samples.

A general analysis of frequency of talk with each partner is illustrated in Table 4. Both the number of subject and partner utterances and the ratio of subject to partner utterances were analysed. This rather broad analysis was based on Fey and Leonard's (1984) work and interpretation of this measurement. According to Fey and Leonard, ratios above 1.0 indicate that the subject was more "active" than the partner in the conversation, whereas ratios below 1.0 indicate that the subject played a more "passive" role than his partner. Ratios near 1.0 indicate symmetrical partner participation in the conversations.

Table 3. Frequency of Talk

Partner	Ratio of Subject Partner Utterances	No. of Subject Utterances	No. of partner Utterances
Free-Play Context			
MOTHER	.64	237	370
CA	1.03	101	98
MLU	0	54	0
TODDLER	.84	116	138
Toy-Task Context			
MOTHER	.66	139	211
CA	1.70	95	56
MLU	0	101	0
TODDLER	.88	70	80

As illustrated in Table 3, D. produced the greatest number of utterances with his MOTHER in both contexts, as compared to the other conversational partners. Similarly, D.'s mother was the most talkative of his conversational partners. In term of the ratio of D.' talk relative to his mother's talk, D. was clearly a less active participant than his MOTHER despite the large number of utterances he produced with this partner. D. was a more active conversational participant than the CA partner, as evidenced by the greater subject/partner ratios in both the free-play and toy-task contexts. He produced significantly less utterances with this partner than with his MOTHER. Similar to his verbal output with the CA partner, D. produced many utterances in interactions with the TODDLER partner who produced a greater proportion of utterances than did D. in each context. Thus, D. was a less active conversational partner than the TODDLER. Finally, D. produced the least number of utterances with the MLU partner. However, this partner did not talk at all throughout the sessions; thus, D. was clearly the more verbally active partner on this dyad.

Table 4 illustrates the range of speech act types expressed by D. with his conversational partners in the free-play and toy-task contexts. Speech act types were analyzed according to the Wollner and Geller taxonomy (1982) (See Appendix C). Immediate echolalia was analyzed according to the functional categories established by Prizant and Duchan (1981) (See Appendix D). Speech act types (non-echolalic) which occured less than twice were not included in this table. Unintelligible and/or uninterpretable utterances were excluded from this measure and all subsequent pragmatic analyses.

Table 4. Proportion of Specific Speech Act Types

Speech Act Type	MOTHER		CA		MLU		TODDLER	
	FP	TT	FP	TT	FP	TT	FP	TT
REQUEST								
Action/Object	.06	.24	.02	.40	.02	.35	.05	.45
Information	.09	0	.02	0	.02	.01	0	.02
COMMENT								
Label	.06	.02	.14	.05	.07	.07	.13	.06
Description	.26	.007	.08	.03	.19	.10	.23	.03
RESPONSE								
Acknowledgement	.02	.007	0	0	0	0	.009	0
To Question	.11	.47	.11	.15	0	0	.01	.03
Clarification	0	.10	.01	.14	0	.01	.009	0
OTHER								
Attention Getter	.03	0	.03	0	0	.02	.07	.02
Protest	.06	.04	0	0	.04	.01	0	.06
Joking/Imaginary Play	.10	0	.02	.01	0	0	0	.08
ECHOLALIA								
Yes Answer	.01	.007	.03	.01	0	0	0	0
Turn-Taking	0	0	.14	0	0	0	0	0
Rehearsal	.004	0	.01	0	0	0	0	0
UNINTERPRETABLE/ UNINTELLIGIBLE	.19	.10	.39	.21	.67	.42	.50	.24

Key: FP = Free-Play
TT = Toy-Task

With regard to conversational partners, D. expressed the broadest range of speech act types with his MOTHER (twelve speech act types). He used eleven different speech act types with the CA partner and ten different speech act types with the TODDLER. D. expresses a narrow range of speech act types with the MLU partner. In addition, D. expressed certain "non-obligatory" speech acts more frequently with his MOTHER than with any other partner. These speech act types were considered non-obligatory in the sense that the child is not required to do anything based on the linguistic and/or pragmatic context. The non-obligatory speech act types include: requests for action/object; requests for information; comment-descriptions; acknowledgements; and joking/imaginary play. Of these speech acts, requests for information, joking/imaginary play and protests were used significantly less often with the other partners. An analysis of obligatory responses will be discussed later.

In terms of differences in speech act selection related to context, an interesting trend emerged in the data. As can be seen in Table 4, D. used a greater proportion of requests for action/object with all conversational partners in the toy-task contexts. Further, a marked decrease in the use of comments was noted in these contexts as compared to the free-play contexts. In contrast, an increase in the use of comments and a decrease in the use of requests for action/object was observed during free-play contexts. No other outstanding patterns emerged in terms of speech act selection across contexts.

A variety of specific speech act types were further analyzed to explore D.'s sensitivity to the age-related characteristics of his conversational partners. These measures have been studied previously by researchers in speech-style variation in normal and language-impaired children (Sachs and Devin, 1973; Shatz and Gelman, 1973; Fey and Leonard, 1981; Fey, Leonard and Wilcox, 1984). These investigators have suggested that these measures reflect the child's responsiveness to the linguistic, cogniitive and social status of his communicative partner. Thus, the use of attention-getter, requests for action/object (or imperatives) and requests for information (or questions) were examined in detail.

Table 5 illustrates the frequency of use of these specific speech act types with each partner.

Table 5. Proportion of Attention-Getter, Requests for Action/Object and Requests for Information.

Partner	Attention-Getter	Requests Action/Object	Requests Information
Free-Play			
MOTHER	.03 (8)*	.06 (15)	.09 (21)
CA	.03 (3)	.02 (1)	.02 (2)
MLU	0	.02 (1)	.02 (1)
TODDLER	.07 (8)	.05 (5)	0
Toy-Task			
MOTHER	0	.24 (33)	0
CA	0	.40 (33)	0
MLU	.02 (2)	.35 (34)	.01 (1)
TODDLER	.02 (1)	.45 (28)	.02 (1)

(*The number of utterances produced by D. is in parentheses).

Table 5 shows an increased use of the attention getter speech act type during free-play contexts with the TODDLER as compared to other partners. Note also that a similar number of attention getters were used with the MOTHER during free-play contexts. Requests for action/object (or imperatives) were used most frequently with the MOTHER as compared to all other partners during free-play contexts. This speech act type was rarely used with the CA or MLU partners during free play contexts.

As previously mentioned, a significant proportion of D.'s utterances with all partners during the toy-tasks encoded requests for action/object. Further, we saw an increase in the use of this speech act type with the TODDLER as compared to other partners during the toy tasks. In contrast, the smallest proportion of requests for action/object (or imperatives) were used with the adult partner during the toy-task contexts. The use of requests for action/object with the CA and MLU partners was similar. Requests for information were infrequently used in both contexts with the CA, MLU and TODDLER partners. However, a marked increase in the use of requests for information was seen with the MOTHER. Note also, that D. did not direct any questions to his MOTHER during the toy-task contexts.

Table 6 illustrates D.'s responses to each partner's questions which were analyzed as to their specific speech act function. This measure explored D.'s use of language in obligatory contexts where he was required to respond to his partners informational needs. The number of D.'s partners' requests for information and clarification were measured, as well as the proportion of D.'s responses to each specific question type. Echolalic utterances which functioned as responses to questions (e.g., yes-answer and turn-taking utterances) were included in the analysis. Additionally, no-responses to questions were measured. Utterances which were unintelligible and/or uninterpretable were excluded from this analysis.

Table 6. Proportion of Specific Response Types to Questions

Partner	# RQ Info	# RQ Clar	Total # RQ	Info RS	Clar RS	E RS	NR
Free-Play							
MOTHER	86	3	89	.31 (27)	0	.03 (3)	.30 (27)
CA	45	17	62	.24 (11)	.06 (1)	.24 (15)*	.18 (11)
MLU	0	0	0	0	0	0	0
TODDLER	25	1	26	.08 (2)	1.0 (1)	0	.69 (18)
Toy-Task							
MOTHER	70	14	84	.91 (64)	1.0 (14)	.01 (1)	.05 (4)
CA	16	19	35	.88 (14)	.68 (14)	.03 (13)	.11 (4)
MLU	0	1NV	1	0	1.0 (1)	0	0
TODDLER	5	3	8	.40 (2)	0	0	.38 (3)

Key: RQ Info = Request for Information
RQ Clar = Request for Clarification
Total RQ = Total Number of Questions
RS = Response
E = Echolalia
NR = No Response
NV = Non-verbal

(* Two echolalic utterances categorized as turn-taking utterances functioned to acknowledge the conversational partner's prior comment. Thus, they were excluded from this analysis.).

Table 6 illustrates that during the free-play contexts D.'s mother asked the greatest number of questions as compared to all other conversational partners. D. responded to his MOTHER'S requests for information more frequently than he did with the other partners. Although requests for clarification were infrequently used by D.'s mother, D. did not respondd to this speech act type. No responses occured frequently (.30) with his mother in the free-play contexts. D. responded to a smaller proportion of requests for information with the CA partner than with his MOTHER. It should be noted that the CA partner used significantly fewer requests for information than D.'s MOTHER. D. infrequently responded to the CA partner's requests for clarification. Unlike D.'s mother who appeared to understand D.'s communicative style, the CA partner used the greatest number of requests for clarification in his interaction with D. D.'s responses to requests for clarification with the CA partner were minimal. No responses occured less frequently with the CA partner than with D.'s MOTHER during the free-play contexts. D. responded less frequently to the TODDLER's requests for information as compared to the MOTHER and the CA partners despite the considerable number of questions asked by this partner. However, D. responded to her one request for clarification. The MLU partner did not ask any questions during the free-play contexts.

During the toy-task contexts, D.'s mother also asked the greatest number of questions and D. produced the greatest number of responses with this partner. Specifically, D. responded to .91 of his mother's requests for information. Further, D. responded to all of his MOTHER's requests for clarification during the toy-tasks. No responses occured infrequently with his MOTHER in these contexts. With the CA partner, who asked less questions than the MOTHER, D. responded to requests for information .86 of the time. Similarly, D. often respondedd to the CA partner's requests for clarification. The TODDLER asked few questions during the toy-task contexts. D. responded to .40 of her requests for information, he did not respond however, to her requests for clarifiation. The MLU partner did not request information from D., although he expressed a non-verbal request for clarification to which D. responded.

In looking at D.'s overall responsiveness across contexts, we see a much higher proportion of responses to both requests for information and requests for clarification in the toy-task contexts. Additionally, there was a marked decrease in the total proportion of no-responses in these contexts. In summary, variation in these measures was seen across both conversational partners and contexts.

In term of echolalia, D. used imitations to turn-take with the CA partner rather frequently in the free-play contexts. This form of responsive comprised .56 of D.'d total responses with this partner. Use of echolalic turn-taking utterances was specific to this partner and context. D. used echolalia with other conversational partners to express yes-answer and rehearsal functions (Prizant and Duchan, 1981). However, the use of echolalia was much more infrequent with the other partners and no additional outstanding patterns emerged. Table 8 illustrates D.'s use of echolalia with each conversational partner.

Table 7. Functions of Language Expressed Through Echolalia*

Partner	Yes Answer	Turn Taking	Rehearsal
Free-Play			
MOTHER	.01 (3)	0	.004 (1)
CA	.03 (3)	.14 (14)	.01 (1)
MLU	0	0	0
TODDLER	0	0	0
Toy-Talk			
MOTHER	.001 (1)	0	0
CA	.01 (1)	0	0
MLU	0	0	0
TODDLER	0	0	0

(*Based on the total number of speech acts used with each partner).

In addition to the above quantitative analyses, various descriptive analyses were completed. Based on general observation, differences were clearly noted in D.'s use of non-verbal communicative behaviors (such as eye-gaze, gestures and bodily orientation) with each conversational partner regardless of context. With his MOTHER, D. used eye-gaze frequently and effectively. Further, in terms of bodily orientation, he consistently sat facing her. With the CA partner, the use of eye-gaze was minimal and body orientation was related to the objects rather than the person. D. appeared to use a variety of gestures in his communicative interactions with the CA partner. With the MLU partner, D. was minimally interactive both verbally and non-verbally. During the toy-tasks, there was a minimal degree of face to face bodily orientation toward the other child. However, attention was generally centered around the objects rather than the other person. D. used gestures minimally during the contexts with the MLU partner. With the TODDLER, an increase in the use of non-verbal communication devices was evident. During one session in particular, D. was strikingly interactive with her as judged by his use of non-verbal behaviors (e.g., good use of eye-gaze and bodilly orientation toward her). Additionally, D. made frequent attempts to engage the TODDLER in social games, such as peek-a-boo.

Another interesting aspect of D.'s interactions with his conversational partners was the variability in overall intelligibility of D.'s speech. The factors related to speech intelligibility included: rate, volume, voice quality, fleuncy and articulation. Table 9 illustrates variations in speech intelligibility across conversational partners. (Utterances which could not be understood following four repeated listening trials were categorized as unintelligible).

Discussion

The present study demonstrated that an autistic child varied his language and communicative style with different conversational partners. Similar to other language-impaired children, the autistic child did not alter his style as extensively as young normal children. The findings suggest that the ability to vary one's communicative style is not an "all or none" skill. Rather, this ability is manifested in degrees of responsiveness to the cognitive, linguistic and social characteristics of the child's conversational partner.

In terms of specific linguistic variations, the autistic child used a shorter mean length of utterance (MLU) with the TODDLER partner as compared to his other partners. This finding is consistent with prior research in normal language development. Unlike SLI children, the autistic child was able to make structural changes in his language in order to simplify utterances directed to younger less (linguistically) "sophisticated" conversational partner. The use of complex sentences was not productive for the subject and therefore did not serve as a reflective measure of changes in linguistic variation in this study.

Variations in pragmatic style were also observed in the autistic child's talk to different partners. The subject's increased use of attention getters to elicit and maintain the TODDLER's attention supports the findings of research with young normal children. Similarily, the autistic child played a more assertive conversational role when taking to the TODDLER and same-aged CA partner as compared to the adult partner. This finding is consistent with the findings of previous research with SLI children. Non-verbal behaviors were also observed to vary with different partners which reflected a marked degree of social awareness. For example, the autistic child made various attempts to engage the TODDLER in social games (such as peek-a-boo), a common practice of adults in play with young children. In contrast to prior research with young normal children and SLI children, the autistic child did not increase his use of requests for information and requests for action/object during inteaction with the TODDLER as a means of initiating and/or directing conversational exchanges. In summary, the autistic child varied his pragmatic style with different partners across various parameters although not to the same extent as young normal and SLI children. The autistic child displayed rudimentary skills in stylistic variation and a degree of sociocentricity in his use of language.

A variety of other pragmatic and paralinguistics variations were observed in the autistic child's talk to different conversational partners. The subject substantially increased his use of echolalia in talk to the CA partner who made frequent attempts to engage D. in conversation about objects and events removed in time and space. It appeared that the autistic child was unable to talk on this child's cognitive-linguistic level and therefore, he relied upon echolalia to maintain interactions with his partner. Speech intelligibility was also noted to vary with different partners. A marked decrease in intelligibility was observed in D.'s talk to the linguistically matched child (MLU) who remained silent throughout all interactions with D.

This finding is consistent with Bernard-Opitz' (1982) observations that autistic children demonstrate changes in speech intelligibility as a function of their conversational partners. In summary, the autistic child demonstrated an awareness of his conversational partners as indicated by the above-mentioned stylistic variations. This finding supports recent research in autism which has noted variation in communicative style in response to person and/or social situation (Bernard-Opitz, 1982; Teitelbaum and Wollner,1982).

Within this study, it was also observed that the autistic child varied in his overall responsiveness to different conversational partners. Specifically, the autistic child responded to a significant proportion of his partner's questions. This is direct contrast to previous findings that autistic children are not responsive to partner feedback (Greenlee, 1981; Snyder, 1982; Yudkovitz et al. 1975). Further, the subject also decreased his overall amount of talk, speech intelligibility and use of non - verbal behaviors with the non - communicative partner (MLU child). This seemed to be in response to this child's lack of interactions with the subject. Thus it was clear that D.'s communicative style was clearly related to his partner's style of communication.

Although a detailed analysis of each of the child's partners' communicative style was not within the scope of the study, several characteristic differences among partners beacame readily apparent. First, D.'s familiarity with the adult partner (namely, his mother) influenced his communicative style so that he was clearly more effective in his interactions with her as compare to the other partners. As stated previously, D. used a broader range of speech act types, a greater proportion of responses and a marked increase in overall speech intelligibility in interactions with his mother. Interestingly, D.'s performance in various areas was notably superior with his MOTHER as compared to the CA partner, unlike the findings of previous research in stylistic variation.

Second, the level of D.'s partners linguistic input also influenced his communicative style. Specifically, D. substantially increased his use of echolalia with the CA partner. It seemed clear that D. did not understand this child's talk. D.'s communicative style was quite different with the "non-communicative" MLU partner who made no attempts to initiate or respond to D. Third, the physical appearance and/or the young age of the TODDLER partner appeared to significantly influence D.'s linguistic and non-verbal play pattern. In sum, these varied partner characterisitcs clearly impacted on D.'s overall communicative style. Further research is necessary to explore which specific partner characteristics influence specific stylistic variations.

In terms of context, situational variations were also observed throughout this study. Of particular interest was the subjects increased use of comments and minimal use of requests for action/object during free-play. In contrast, requests for action/object were frequently used during the toy-tasks while comments were infrequently used. This trend in the data reflected an appropriate selection of speech act types to fit the different situations and thus, illustrated the autistic child's awareness of different social situations. Further, during the toy-task contexts, D. appeared to be a more responsive conversational partner. As stated previously, we noted a marked increase in D.'s talk to the MLU partner (during toy-tasks) which seemed to reflect the effect of prior training. It is suggested that more "structured" contexts of this type be utilized in language and communication therapy to enhance the autistic child's communicative competence with other partners.

The results of this study revealed wide variations in this autistic child's overall communicative abilities. Specifically, the subject used both a wide and narrow range of speech act types dependent upon the other partner. Similarly, the subject used non-verbal comunicative behaviors inconsistently throughout this study. It is important to reiterate that the subject's communicative effectiveness was clearly influenced by his partner's style of interaction. His inability to initiate and/or maintain conversational exchanges was especially evident with his non-communicative partner (i.e., the MLU child).

In sum, the autistic child in this study displayed a variety of behaviors usually considered "atypical" of the autistic population. This finding suggets that there are distinct and different profiles of the communicative abilities of autistic children. For example, D. used a limited number of requests during spontaneous play. This contradicts some of the literatue in autism which emphasizes that the use of requests is a predominant speech act type (Baltaxe and Simmons, 1975; Fay and Schuler, 1980; Wetherby and Prutting, 1984). In fact, the majority of this autistic child's utterances functioned as comments, a speech act type that supposedly occurs infrequently in autism (Fay and Schuler, 1980). Another interesting finding was that this autistic child used a range of non-verbal communicative devices with his conversational partners. Again, this finding contradicts the research in autism which claims that the use of non-verbal gestures is diminished and/or absent in the communication of autistic children (Baltaxe and Simmons, 1975; Fay and Schuler, 1980; Tager-Flasberg, 1981).

It is highly important to note that there are sub-groups of autistic children who exhibit varying degrees of skill in certain social and linguistic abilities. Further, it is clear that there is limited research on the linguistic and pragmatic changes that occur overtime in autistic children. Research on the nature of autism in later childhood is scarce.

The study of pragmatics emphasizes that "language is contextually variable and that the child's speaker behaviors vary as a function of the major characteristics of the listener" (Craig, 1983, p. 112). Thus, communicative competence implies knowledge of how to converse with different partners. In intervention, the issue arises as to the clinician's viability as the primary interactant with the autistic child. The findings of this present study support the notion of contextual variability and clearly demonstrate that an autistic child's communicative competence is markedly influenced by his conversational partner.

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In terms of treatment, Craig's (1983) notion that the language clinician should act as a facilitator of the child's language and communication development with other conversational partners must be emphasized. It is strongly suggested that autistic children would benefit from interactions with the clinician which then progress to interactions with adults and peers facilitated by the clinician, and finally, to interactions with adults and peers alone. These different conversational partners would not merely be "agents of carry over" but would provide the child with the opportunities to learn how to interact with different people (Craig, 1983). The need to work on the autistic child's social interactive skills with varying partners is strikingly evident. Broadening the autistic child communicative experiences with different partners should be an integral part of language therapy from the start and not some final goal of "carry-over".

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Appendix A

Stimulus Material

The following toys were utilized in this study:

Toy-Task
1. Child Guidance Pumpkin Farm
2. Playschool Lift and Load

Free-Play
1. Colorform:
   a. Snoopy How's the Weather ? Dress Up Set
   b. "Chips" Play Set
   c. Cabbage Patch Kids Play House
   d. Gremlins Deluxe Play Set

2. Legos:
   a. Preschool Basic Building Set
   b. Preschool Camping Building Set
   c. Hospital
   d. Police Headquaters
   e. Building Set with People

3. Play-Doh:
   a. Modeling compound
   b. Breakfast Fun Play Set

4. Fisher-Price:
   a. Family Play House
   b. Stove Set
   c. Sink Set

Appendix B

Summary of Conversational Partners and Contexts

The various conversational partners and observational contexts of the study were as follows:

SESSIONS	PARTNERS	CONTEXTS	MATERIALS FOR TOY-TASK
I	MOTHER	Free-Play Toy-Task #1	Pumpkin Farm
II	TODDLER	Free-Play Toy-Task #2	Loading Dock
III	MLU	Free-Play Toy-Task #1	Pumpkin Farm
IV	CA	Free-Play Toy-Task #2	Loading Dock
V	CA	Toy-Task #1 Free-Play	Pumkin Farm
VI	MLU	Toy-Task #2 Free-Play	Loading Dock
VII	TODDLER	Toy-Task #1 Free-Play	Pumpkin Farm
VIII	MOTHER	Toy-Task # 1 Free-Play	Pumpkin Farm

Appendix C

Definitions of Communicative Acts

The communicative acts used in this study were derived from the Wollner and Geller (1982) taxonomy and adapted from the work of Dore, Gearhart and Newman (1978).

REQUESTS involve soliciting information or actions.

1. Requests for action/object involve the speaker directing the listener to perform an action, e.g., gimme ride.
2. Requests for information involve the speaker obtaining solicited information from another participant, e.g., what did watch on TV?
3. Requests for clarification involve the speaker seeking clarification of another person's remark, e.g., what did you say?

COMMENTS include descriptions and/or identification of observable events in the environment and statements which report facts or state rules.

1. Labels involve identification of objects, events, persons, etc., e.g., that's a car.
2. Descriptions predicate information about events, properties or locations of people or objects, e.g., it fall down.

RESPONSES involve the speaker providing solicited information to another speaker's prior remark or the acknowledgement of another speaker's prior atterance.

1. Acknowledgements involve the speaker recognizing another participant's prior remark using verbal fillers which merely accompany the interaction without providing new or additional information, e.g., yeah, okay, oh.
2. Responses to questions involve the speaker providing the solicited information to a wh-question or yes/no question.
3. Clarifications involve clarification of the speaker's previous remark usually in direct response to a clarification request.

PERFORMATIVES accomplish acts and estabblish facts by being said.

1. Protests involve the speaker expressing some objections to another individual's behavior, e.g., stop that, no.

2. Joking/imaginary play involves the speaker engaging in humorous / playful interactions with self or others, e.g., teasing, playing peek-a-boo.*

ORGANIZATIONAL DEVICES accompany an interactional exchange and control the conversation flow and maintain personal contact with the other speaker(s).

1. Attention getters involve the speaker attempting to gain the listener's attention, e.g., hey, John.

UNINTERPRETABLE/UNINTELLIGIBLE speech acts could not be determined due to verbal (e.g. articulation) or non-verbal (eye-gaze) factors.

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*Supplementary category to this taxonomy.

Appendix D

Functions of Echolalia

The functions of immediate echolalia were derived from the categories established by Prizant and Duchan (1981). The features of the functional categories are summerized below.

Echo Category	Evidence of attention	Echo directed to person	Degree of change	Timing of echo re: behavioral	Evidence of comprehension	Expectation of response from adult	Comments
Yes-Answer	Yes*	Yes*	Minimal	not applicable	Yes*	Yes*	Verbal or non-verbal evidence of affirmation
Turn-Taking	Yes*	Yes*	Minimal	not	No*	No	-------
Rehearsal	Yes*	No, with expectations	Selective; high information segmentals	Prior to	Yes*	No	Delay between echo & verbal or non verbal

*Core characteristics

The Effect of Contextual Variation on Language Sampling

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Abstract

This study was designed to investigate the effect of contextual variation on language sampling. A language-impaired child's communicative interactions were studied in two settings, the clinic and the home, while interacting with one of two communicative partners; the mother and an unfamiliar clinician. Three specific issues were addressed: 1) how language samples differ when contextual variables are manipulated; 2) what dimensions of language ability are susceptible to change when language is sampled in different contexts; and 3) in what ways the language collected in the clinic with an unfamiliar clinician is representative of the child's language. Results indicated that home samples yielded the highest M.L.U.'s and the greatest total output of language. Language sampled in the clinic during clinician-child interactions resulted in the most limited sample. This study demonstrated that a child's language ability may vary depending on the context in which it is sampled.

Throughout human development there is a progressive mutual accomodation between a growing organism and the changing immediate environments in which it lives. This is an ecological process which is reciprocally affected by the network of relations between the developing person and an immediate context (Bronfenbrenner, 1977). Context is operationally defined as a place with physical features in which the participants engage in particular activities in particular roles for particular periods of time. Each context possesses a separate yet equally relevant composition of factors which may evoke varying behaviors.

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The trend in recent research within a variety of disciplines has been to study the child's behavior in "naturalistic contexts" beyond the confines of the laboratory. This trend has been particularly popular within the field of developmental psycholinguistics. Here, the study of child language development in recent years has largely been focused on observational data collected in natural interactions with mothers during the course of everyday activities and routines. This development has led researchers away from the previous genre of research that Bronfenbrenner (1977) refers to as "the science of the strange behavior of children in strange situations with strange adults for the briefest possible periods of time" (p. 513).

In contrast, an ecological experiment investigates existing accomodations between the individual and its immediate context by creating a systematic contrast between two or more contexts or their structural components. According to this ecological viewpoint, in order "to understand the relation between the developing person and some aspect of his environment, try to budge one and see what happens to the other" (Bronfenbrenner,1977, p. 518). In this regard, Bronfenbrenner refers to the "as yet unexploited power of the laboratory as an ecological contrast for highlighting the distinctive features of other types of settings as they affect behavior and development" (p. 516).

One aspect of the developing person that is certainly subject to contextual variation is communicative interaction. As the individual adapts to changing contexts, accompanying variations in communicative behaviors may be observed. From the language therapist's perspective, thr notion of variations in communicative skills is critical in terms of both assessment and treatment. Specifically, the increasing interest in language use and the effects of context (communicative partner and setting) on language use has raised the question of how best to evaluate, as well as treat the disordered child's communicative abilities.

The purpose of language assessment is to provide the significant information needed for identifying, diagnosing, and remediating deficits in communicative abilities (Danwitz, 1981). Pragmatic theory and its attention to language use in context has shifted the focus of language assessment away from structured contexts and standardized tests toward more "naturalistic contexts" and language sampling. In the 1980's, language performance is generally observed during naturally occuring events with minimal adult control and interference (Bloom and Lahey, 1978). The language sample collected during "naturalistic contexts" is analyzed as a means of evaluating language skill. Recent research has been directed to determining the representativeness of these language samples. The research suggests that there are several major contextual variables which may affect the child's output (Hall and Cole, 1978; Olswang and Carpenter, 1978; Scott and Taylor, 1978; Kramer, James, and Saxman, 1979), such as communicative partner and the setting.

In a review of this literature, Gallagher (1983) concluded that while studies taken as a whole reveal that language is affected significantly by these contextual parameters, individual data may differ from group trends and findings may conflict. Discrepancies may be attributed to the fact that this research has focused on different domains of language and utilized different analytic measures. Differences may also be attributed to the fact that previous studies varied in their experimental design and control for contextual variables.

In terms of setting and communicative partner, Scott and Taylor (1978) investigated the effects of familiar versus unfamiliar contextual variables by examining the syntax of 12 normal children ages two to five. Subjects were selected in order to represent a variety of linguistic levels (M.L.U.'s 3.0 - 6.0). Language samples of 125 utterances were collected in a clinic setting during clinician-child interaction and in the home during mother-child interaction. Results indicated that language samples obtained in the home were characterized by longer utterances for children whose M.L.U was 4.0 - 5.0. It was also found that clinic samples included more descriptions of ongoing activities whereas home samples consisted of more frequent use of complex sentences, questions, and past tense and modal verb forms.

Similarly, Kramer, James, and Saxman (1979) compared language samples obtained in the home with mothers to those obtained in the clinic with clinicians. Each sample consisted of 50 utterances. The subjects were 10 children ages three to five who had been referred for speech and language diagnostics. All subjects had speech and/or language problems ranging from mild to severe. Kramer et al. found that for most of the subjects, home samples yielded higher M.L.U.'s than clinic samples. Although no difference between D.S.S. (Lee, 1974) scores obtained in the clinic and home samples were noted, when scores were converted to estimated language age, most children scored higher in the home sample.

Olswang and Carpenter (1978) examined the effects of the communicative partner on the language obtained from nine language-impaired children ages three to six in a clinical setting. Subjects were selected based on a 25 minute sample obtained in the clinic. Measures included the examination of semantic and lexical flexibility and diversity, total number of utterances, M.L.U., and use of grammatical morphemes. After comparing language obtained with both a familiar adult (mother) and an unfamiliar adult (clinician), Olswang and Carpenter found that mothers elicited a significantly greater number of utterances from their language-impaired children. They found no significant lexical, semantic, or syntactic difference between the two contexts. The authors speculated that perhaps "pragmatic, sociolinguistic measures that analyze the function of language would reveal differences in the two elicitation conditions" (p. 85).

Hall and Cole (1978) examined the influence of two settings, a classroom and a supermarket, on the language of three to four year old Head Start Nursery School children. In both settings, the children interacted with teachers. Using a criteria of M.L.U. and conversational acts, Hall and Cole found that the children's classroom speech was dominated by short M.L.U.'s for responses to wh- questions and even shorter responses for yes/no questions. Descriptions with typically longer M.L.U.'s were found to dominate the children's supermarket talk.

An investigation of adult input similarly revealed variation with regard to setting. Adults were found to request more in the classroom, while more mutual conversational exchanges were noted in the supermarket.

Results of a replication study led Hall and Cole to conclude that a change in setting was not solely responsible for the significant language variation noted. According to Hall and Cole, it was the participants' understanding of the task and their role in that task (as teacher and student in an "examination" or as people sharing an "enriching experience") which led to the variation in discourse structure noted in the two settings.

The research discussed suggests that contextual variables such as communicative partner and setting can affect language output.Thus, it is possible that a child's expressive language may be underestimated in terms of M.L.U., amount of total output, and semantic or syntactic complexity when sampled in the clinical setting. The language sample obtained in the clinic may best be thought of as representative of a particular dyadic interaction within a particular setting, rather than as representative of the child's communicative skills in general or of his "richest" communicative skills.

The results and implications of these studies taken together with the notion of ecological contexts lead us to reconsider the representativeness of the language sample obtained in the typical clinician-child interview. As Bronfenbrenner (1977) suggests, "when a laboratory study is regarded as representative of behavior elsewhere, evidence must be provided of an empirical relation to similar activities in the other setting-- in other words, validation against an external ecological criterion, with the possibility of systematic divergence explicitly taken into account" (p. 517).

Since a laboratory context ("strange situation, strange adult") is the typical context for obtaining language samples, researchers in language disorders must address the issue of how these samples are representative of language used in other settings and how they are not. This research study attempts to describe the "systematic divergence" between language samples collected in the clinic versus those collected in the home and those collected during interactions with an unfamiliar adult versus those collected during interactions with the mother.

Previous studies designed to address the issue of the effects of contextual variation on language sampling have been limited either because of the lack of control of certain variables or because all domains of language were not analyzed. Studies which have compared the interactions of mother-child in the home with clinician-child in the clinic (Scott and Taylor, 1978; Kramer et al., 1979) have focused on two variables at once, thus obscuring the factors which account for the differences found. Olswang and Carpenter's (1978) study compared mother-child to clinician-child interactions but limited their observations to a single setting. No study to date has examined the effects of both communicative partner and setting on these dyadic interactions. Further, none of the previous studies have examined all aspects of language ability (i.e. form, content, and use) and the potential interactions between these domains of language relative to setting and communicative partner.

The present study was designed to examine the variability in language use of a language-impaired child across contexts. As part of the experimental design, this study attempted to approximate the conditions under which a language sample is collected in the typical speech/language diagnostic evaluation. The study was of observational design employing the notion of "ecological contrasts." The following questions were addressed:

1. How do the language samples of a language-impaired child differ when setting is varied and communicative partner is held constant?
2. How do the language samples of a language-impaired child differ when communicative partner is varied and setting is held constant?
3. What conclusions can be drawn about the dimensions of language ability which are susceptible to change when language is sampled in different contexts?
4. In what ways is the language sample collected in the clinic with an unfamiliar clinician representative of the child's language and in what ways is it not representative?

Method

Subject

The subject (M.E.) was a 3.10 year old Down's Syndrome female. Initial assessments indicated cognitive and language delays. M.E. had been enrolled in speech/language therapy at the Queens College Speech and Hearing Center for six months prior to the study. Therapy focused on development of early occurring form-content categories and lexical and conceptual development. One to two word utterances were introduced through clinician modeling and expansion. M.E. was at the one to two word stage of language development at the time of the study.

Apparatus

The experimental procedure was conducted in two settings:
1. a therapy room at the Queens College Speech and Hearing Center
2. The child's bedroom in the home

Each session was videotaped using a Sony SLO 340 with a Sony Trinicon model # HVC-2200. Simultaneously, the sessions were audiotaped on a Panasonic RQ 356A. Familiar pre-school toys were used for the warm-up period and the primary interaction in each session (see Appendix A). A core of six toys were divided into two sets of three. Sets were matched according to age level. Each set consisted of a building toy, a representational toy, and a water toy. The interactants had access to Set # 1 in the home and set # 2 in the clinic. A set of two backup toys were available to each dyad in all conditions.

Procedure

Two experimental pre-sessions were conducted in each setting one week prior to taping. In each pre-session, video equipment was set up for a one hour period in order to get the child accustomed to the presence of the camera. This procedure was conducted so that results obtained would not be invalidated by the child's reaction to the presence of the video equipment.

The child's communicative interactions with a significant other were observed in the following four conditions:

Condition I - mother/child in the home (MC/H)
Condition II - mother/child in the clinic (MC/CL)
Condition III - unfamiliar clinician/child in the home (CC/H)
Condition IV - unfamiliar clinician/child in the clinic (CC/CL)

One of the experimenters acted as the unfamiliar clinician. The mother and the child's clinician were present during all tapings.

The sessions were taped in the following order: mother-child in the clinic; unfamiliar clinician-child in the clinic; unfamiliar clinician-child in the home; mother-child in the home. Clinic sessions were taped prior to home sessions so that the initial clinician-child interaction would simulate a diagnostic evaluation in which a child interacts with an unfamiliar adult (clinician) in a less familiar setting (clinic). (Obviously, the clinic setting was not unfamiliar to the child since she had been receiving therapy at this facility). The mother-child interaction was the first session taped in the clinic due to the availability of the interactants. Consistent with the clinic sessions, the mother was scheduled to interact with the child in the initial home taping, however, due to illness, the order could not be preserved.

Each adult was instructed to interact with the child as they would in a natural play situation and to introduce a new toy when the child became either disinterested or fatigued.

Following a warm-up period of 10 minutes, 55 minutes of interaction were taped. All four interactions were taped over a two week period.

Each session was recorded on audiotape and videotape and transcribed independently by two experimenters. Interactions were transcribed within seven days of the taping (see Appendix B for transcript format). The reliability of each transcript was ensured by having the two experimenters compare transcripts and resolve corrections and disagreements before beginning analysis of samples. Whenever the two transcribers could not agree on the major constituents of an utterance, that utterance was counted as unintelligible. Samples were then analyzed jointly by the same two experimenters and checked by a third to ensure the reliability of the analyses. Analyses were performed on both total and equated samples. Samples were equated (first 150 utterances) in order to make comparisons across conditions (personal communication, Lahey, 1985).

A variety of syntactic, semantic, and pragmatic (form, content, use) measures were used to analyze the child's utterances. These included measures which looked at each domain of language and those that looked at the interrelationship between domains.

Data analyses were primarily linguistically based. There were few occasions where the child used solely nonlinguistic means to communicate. These instances were recorded pragmatically as communicative acts but were excluded from the semantic analysis.

Utterances whose semantic relation or speech act function could not be determined, either because the utterance was partially or totally unintelligible or because the function was equivocal, were catergorized as undeterminable. These utterances, were excluded from the linguistic analyses, but counted as a conversational turn.

Form measures included total number of utterances, Mean Length of Utterance (M.L.U.), and a morphological analysis. M.L.U. was calculated in each condition (see Appendix C) for conventions for determining M.L.U.). Use of morphological inflections such as plural -s and present progressive -ing was also analyzed (see Appendix D).

Content was assessed using an adapted version of Bloom and Lahey's (1978) categories for the semantic analyses (see Appendix E). Single word utterances which were ambiguous in meaning or undeterminable due to lack of contextual information were excluded from the analysis.

Use involved pragmatic analysis of speech act function based on Gerber-Wollner's (1985) taxonomy (see Appendix F). Speech acts were determined by examining utterances within the linguistic and non-linguistic context in which they occured. Eye gaze, intonation patterns, and gestures contributed to determining communicative intent.

Form/Content. Type-token ratios were calculated in order to examine the diversity of forms used to encode semantic relations. A type-token ratio was derived by dividing the number of different utterances in a given semantic relation (type) by the total number of utterances expressing that relation (token). For example, if a subject encoded recurrence for a total of 10 utterances (tokens) and 5 different lexical items were used (types), then the type-token ratio for this relation would be 5/10 or .50.

Form/Function. Type-token ratios were also calculated to examine the diversity of forms used to express speech acts (see above procedure).

Additional measures were designed to investigate the possible effects of adult input on the child's language output in each condition. Each of the child's utterances was designated as being discourse related (preceded by a linguistically or contextually related adult utterance) or as self initiated (preceded by either silence or an unrelated adult utterance). A discourse analysis was done in an attempt to account for differences in the frequency distributions of semantic relations and speech acts with different partners. The adults' total output and number of utterances per turn were also examined.

Results

Subject 1

As can be seen in Table 1, the total number of child utterances ranged from 150 to 347 within time equated samples. The child was least verbal in the clinic with the unfamiliar clinician and most verbal in the home with the mother. In each condition, the child's M.L.U. was calculated for both total and equated samples. Table 1 reveals that the home samples yielded higher M.L.U.'s in both the total (1.60, 1.63) and the equated (1.37, 1.48) samples. When M.L.U.'s from home samples were averaged (1.62) and compared with averaged clinic samples (1.29), a significant difference was noted. As can be seen, the clinic sample with the unfamiliar adult resulted in the lowest M.L.U.'s (1.12, 1.04). According to Bloom and Lahey's (1978) phases of language development, the child's MLUs across the four conditions would be representative of three different phases of language development.

Table 1. M.L.U. and total number of utterances in all conditions

Condition	M.L.U.(total)	M.L.U.(equated)	Total # Utterances
I	1.60	1.37	347
II	1.46	1.13	314
III	1.63	1.48	323
IV	1.12	1.04	149

Key: Condition I = mother/child home
Condition II = mother/child clinic
Condition III = clinician/child home
Condition IV = clinician/child clinic

In terms of morphological usage, the plural -s was used productively in conditions II and III. It was noted that in these two conditions, there were more obligatory contexts for the plural -s than in conditions I and IV. No other grammatical morphemes were used productively.

The range and frequency distribution of productive semantic relations for the total sample in all conditions is presented in Table 2. A category was considered productive when at least four different lexical types were used to encode that category (Bloom and Lahey, 1978). For example, the semantic relation "existence" would be considered productive if the child encoded this relation with four different nouns ("butter", "horse", "meatball", and "sink").

Table 2. Frequency distribution of productive semantic relations in total samples.

	Conditions			
Semantic Relations	I MC/H	II MC/CI	III CC/H	IV CC/CI
Existence	.20	.23	.04	.17
Rejection	.08	.08	.22	.24
Action	.18	.12	.17	.13
Locative Action	.02	.02	.03	-
Attribution	.02	.02	.02	-
Possession	.01	.02	-	-
Recurrence	-	.04	-	-
State	.02	-	-	-
Ritualistic	.18	.08	.24	.13

The child produced a wider range of semantic relations when interacting with the mother than when interacting with the clinician. As can be seen, possession, recurrence, and state were not encoded when the subject interacted with the clinician.

When examining the frequency distribution of semantic relations, it was found that the most frequently occurring relations (existence, rejection, action, ritualistic) were the same in all conditions. However, across conditions differences were noted in the frequency distribution of these four most frequently occuring relations. More specifically, rejection was the most frequently encoded relation in clinician - child dyads (23%), while existence was the most frequently encoded relation in mother - child dyads (21.5%). When communicative partner was held constant and setting varied, action and ritualistic utterances were produced more frequently in the home (21%) than in the clinic (10.5%).

When samples were equated (see Table 3), the range of semantic relations expressed did not differ significantly across conditions. The one exception was locative action which was encoded productively in Condition III only.

When examining the frequency distribution of semantic relations in the equated sample, it was found that the most frequently encoded relations were the same in all conditions. However, across conditions, differences were noted in the frequency distribution of the four most frequently encoded relations. More specifically, rejection was encoded more frequently with the clinician (average 20%). When communicative partner was held constant and setting varied, existence was encoded more frequently in the clinic (average 20.5%) than in the home (10.5%), while ritualistic utterances were produced more frequently in the home(18%) than in the clinic (9%).

Table 3. Frequency distribution of productive semantic relations in equated samples

	Condition			
	I	II	III	IV
Semantic Relation	MC/H	MC/CI	CC/H	CC/CI
Existence	.14	.24	.07	.17
Rejection	.09	.05	.16	.24
Action	.16	.10	.16	.13
Ritualistic	.18	.05	.18	.13
Locative Action			.03	

As can be seen, an overall decrease in the range of semantic relations was noted when samples were equated. The semantic relations most frequently encoded in the total sample (rejection, existence, action, ritualistic) were the only relations productive in all four conditions when samples were equated. Similar to the total sample, rejection was produced most frequently in clinician - child dyads and ritualistic utterances occurred more frequently in the home. Unlike the total sample, encoding of existence was found to be most influenced by variation in setting rather than communicative partner when samples were equated.

The range and frequency distribution of productive speech acts for the total sample in all conditions is presented in Table 4. As can be seen, the child produced a wider range of speech acts during mother-child interactions than during clinician-child interactions. More specifically, request direct attention, request information, and comment on people were not expressed or not expressed productively during clinician- child interactions.

Table 4. Frequency distribution of productive speech acts in total sample

	Condition			
	I	II	III	IV
Speech Act	MC/H	MC/CI	CC/H	CC/CI
Request Action	.11	.07	.11	.11
Comment Action	.09	.08	.11	.06
Comment Object	.21	.21	.08	.13
Request Object	-	.13	-	-
RQ - Direct Attn.	.02	.04	-	-
RQ Information	.03	.03		
Protest	-	.01	.03	-
Comment People	.01	.03	-	-
Comment Self	-	-	.02	-
Discourse- Rejection	.08	.08	.20	.21

When examining the frequency distribution of speech acts, it was found that the most frequently occurring speech acts (request action/help, comment on action/state, comment on object, discourse rejection) were the same in all conditions with one exception. Request object was expressed frequently in Condition II only. Across conditions, differences were noted in the frequency distribution of the four most frequently expressed speech acts. More specifically, comment on object was the most frequently used speech act in mother - child dyads (average 21%), while discourse rejection was most frequently expressed in clinician - child dyads (average 20.5%). No patterns were evidenced when communicative partner was held constant and setting was varied.

When samples were equated (see Table 5), the range of speech acts did not differ significantly across conditions. Request object and protest were expressed productively in one condition each.

Table 5. Frequency distribution of productive speech acts in equated samples

	Condition			
Speech Act	I MC/H	II MC/Cl	III CC/H	IV CC/Cl
Request Action	.09	.06	.09	.11
Comment Action	.09	.09	.09	.06
Comment Object	.13	.24	.11	.13
Request Object	-	.18	-	-
Protest	-	-	.04	-
Discourse-Rejection	.09	.08	.13	.21

When examining the frequency distribution of speech acts expressed in the equated sample, it was found that the most frequently expressed speech acts (request action/help, comment action/state, comment on object, discourse rejection) were the same in all conditions with one exception. Request object was expressed frequently in Condition II only. Across conditions, a difference was noted in the frequency distribution of discourse rejection which was most frequently expressed in clinician-child dyads (17%).

As can be seen, when samples were equated, a decrease in the range of productive speech acts expressed was noted. The speech acts most frequently expressed in the total sample (request action/help, comment action/state, comment on object, discourse rejection) were the only speech acts expressed productively in all four conditions when samples were equated. Similar to the total sample, discourse rejection was most frequently expressed in clinician-child dyads.

Type - token ratios were calculated in order to determine the diversity of forms available to encode semantic relations. As can be seen in Table 6, an average type - token ratio was calculated for each relation as a comparative measure. In other words, the type-token of each condition was compared to the average type-token across conditions to see if there was more or less diversity in each condition.

Table 6. Form/content type-token ratios

	Condition				
Semantic Relation	I	II	III	IV	Average
Rejection	.23	.43	.17	.36	.30
Existence	.71	.59	.67	.60	.64
Action	.72	.65	.67	.50	.64

No significant differences were noted in the amount of diversity when setting was held constant and communicative partner varied. However, when communicative partner was held constant and setting varied, significant differences were noted in the amount of diversity. The subject encoded rejection with more diversity in the clinic (.43, .36) than in the home (.23, .17). Existence was encoded with less diversity in the clinic (.59, .60) than in the home (.71, .67). Similarly, action was encoded with less diversity in the clinic (.65, .50) than in the home (.72, .67).

Type - token ratios were also calculated in order to determine the diversity of forms available to express speech acts. As can be seen in Table 7, an average type - token ratio was calculated for each speech act as a comparative measure.

Table 7. Speech act type-token ratios

	Condition				
Speech Act	I	II	III	IV	Average
RQ Action/Help	.71	.81	.67	.85	.76
Comment Action/State	.97	.81	.76	.60	.79
Comment Object	.86	.71	.77	.65	.75
Discourse Rejection	.21	.36	.25	.37	.30

When setting was held constant and communicative partner varied, the subject used a greater diversity of forms to comment on action/state with the mother (average .89) than with the clinician (average .68). When communicative partner was held constant and setting varied, several differences were noted. The subject was found to be more diverse when commenting on objects in the home (average .82) than in the clinic (average .69). The subject expressed discourse rejection with a greater number of forms in the clinic (average .37) than in the home (average .23).

Additional measures designed to investigate the effect of adult input on the frequency distribution of semantic relations revealed that in terms of existence, the difference noted could be attributed to maternal input. More specifically, 48% of the child's utterances encoding existence in mother-child dyads were discourse related. Further, 58% of these discourse related existence utterences were elicited by requests for information such as "What's this?" or "Tell me about it." In contrast, 26% of the child's utterances encoding existence in clinician-child dyads were discourse related with 9% of these being elicited by requests for information. Further examination of adult input revealed that there were no significant differences noted in the amount of requests for information expressed by the mother (avg. 21%). This suggests that the child had the same opportunity to encode existence with both communicative partners, but was less responsive to these bids when interacting with the unfamiliar clinician.

An examination of adult input failed to reveal discourse related factors which could account for the discrepancy in the amount of rejection that was encoded with the mother and the unfamiliar clinician.

In terms of adult total output, the mother occupied a significantly greater amount of the conversational exchange (avg. 71%) than the clinician (avg. 52%). Further, the mother was found to take significantly more utterances per turn during the conversational exchanges than the clinician.

Discussion

The present study examined the effect of contextual variation on the syntactic, semantic, and pragmatic dimensions of language. While previous research has indicated that specific domains of language may be susceptible to change when communicative partner and/or setting is varied (e.g. M.L.U. or syntactic complexity), a more comprehensive and synergistic analysis of language variation in language-impaired children has not been done.

Results of this study indicate that certain aspects of language performance are clearly influenced by contextual variables, while other aspects of language performance remain constant across contextual variation. For example, some aspects of language form were significantly affected by variation in context setting. Specifically, the child studied was most verbal, demonstrated higher M.L.U.s, and displayed the most form diversity in the context of the home. Thus, in terms of selected aspects of language form, the home setting yielded the "richest" language samples.

Other dimensions of language, such as the range of productive semantic relations and speech acts expressed, were affected most by variation in communicative partner. Specifically, a wider range of both semantic relations and speech acts was observed in mother-child interactions. These results indicate that relative to these aspects of semantic and pragmatic ability, the mother-child dyad resulted in the "richest" language samples.

As noted above, results of this study also indicated that certain aspects of language performance were stable regardless of contextual variation. For example, the most frequently encoded semantic relations remained constant across context setting and communicative partner. Further, the most frequently expressed speech acts were similar in all conditions.

Within this consistent pattern or profile, specific differences were noted which could be accounted for on the basis of contextual variation. For example, in terms of semantic relations, rejection was the most frequently encoded relation during clinician-child interactions, while existence was the most frequently encoded relation during mother-child interactions. In terms of the latter finding, further analysis of the data indicated that the mother's input may have accounted for the greater percentage of existence encoded during mother-child dyads. In both mother-child interactions, a significant proportion of the existence utterances appeared to be elicited by the mother's prior "talk." In other words, the child's use of existence was contingent on her mother's comments and requests for information ("What's this?" "Now which one?" "Tell me").

The finding that comment on object was the most frequently expressed speech act during mother-child interactions is related to the results discussed above. In other words, the overlap between utterances coded within the semantic domain as "existence" and those coded within the speech act domain as "comment on object" is clear. This inseparability of semantics and pragmatics is also noted in the frequent occurence of the semantic relation, rejection, and the speech act discourse-rejection during clinician-child interactions.

As can be seen, the results of the present study revealed variability of language use as well as invariability of language use relative to different aspects of language performance, different context settings, and different communicative partners. The issue of how the language sample collected in the clinic with the unfamiliar clinician was representative of the child's language was addressed within this framework. Relative to M.L.U., total output, and range of semantic and pragmatic abilities, the "clinic" sample was, in fact, limited when compared to the child's full range of language capacity. Thus, the language sample obtained in the "simulated" clinical interview was not "representative" of the child's ability in certain domains of language and would have led to an underestimation of the child's ability in those areas.

The "richness" noted in the child's language in certain contexts is interesting to explore. Results favoring "richness" in the home may be attributed to the presence of established routines, the familiarity of the surroundings, and the overall comfort related to being in one's own home. According to Kramer et al. (1979), language samples obtained in the clinic during clinician-child interactions may be different from home samples due to the unfamiliarity of the topic, task, and the communicative partner.

Results favoring "richness" in mother-child dyads may be attributed to the familiarity of the participants and the shared and established routines and patterns of communicative interaction which exist between them. Nelson and Gruendel (1979) suggest that shared knowledge between mother and child may result in "scripted" interactions which support conversational exchange and enhance communicative competence. Thus, interactions between the child and an unfamiliar clinician which lack the conversational support of shared knowledge may understandably result in a more limited "display" of the child's language ability at early language levels.

If the primary goal of language sampling is to obtain a representative "picture" of the child's language, our results suggest that current concepts of language sampling procedures may be inadequate. Since language appears to be richer in the presence of a familiar communicative partner and a familiar setting, language assessment should move in the direction of extending the boundaries of the typical sampling context. Having said this, we should return to the notion of "ecological context" which will bring us full circle. The point should be made that the clinical context does, in fact, become a part of the language-impaired child's life. In this sense, this "strange situation" with this "strange adult" (Bronfenbrenner, 1977) soon becomes an ecological context for the language-impaired child. Taking this one step further, the child's behavior in the clinical context is not worse than or less representative of his behavior in other contexts, but simply typical and representative of his behavior in that setting with that partner.

This interpretation lessens the somewhat negative view of the clinical environment that has emerged as an outgrowth of recent pragmatic research and suggests that it be considered relative to its unique status as, not worse, but different.

In terms of therapy, the advantages of collecting mother-child samples and/or home samples in addition to clinic samples is interesting to consider. With this added information, initial goals of training could focus on matching the child's language performance in the clinic to his/her own performance in more familiar contexts, rather than using a more arbitrary model to derive therapy goals. In this way, the early goals of language intervention would focus on facilitating the child's use of existing communicative competence, rather than on teaching him/her something "new".

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Appendix A

Toys

	Building	Representational	Water
Set # 1	Tyco Pre-school Blocks	Happy Valley School	Shelcore Water Pal
Set # 2	Loc Blocks	Happy Valley Farm	Fisher Price Sink Set

Backup Toys: Playdoh Fun Factory, Hasbro Preschool Thing a Ding Dings

Appendix B

Transcript Format

Context Variables

Name of Child____________________
Chronological Age________________
Date of Sample__________________
M.L.U._________________________

Setting______________________
Interactants___________________
Length of Interaction__________
Materials Used_________________
Time of Day____________________

Key

U = unintelligible
... = pause
( ) = questionable transcription
/ / = phonetic transcription

Adult Utterances   Nonlinguistic Context   #   Child Utterances

Appendix C

Conventions for Calculating M.L.U.*

1. Allow for a ten to fifteen minute warm-up period before beginning the transcription.

2. Transcribe the first 150 consecutive utterances following the warm-up period.

3. Only fully transcribed utterances are used. If an utterance contains one unintelligible element in which the number of morphemes can be determined, it is included in the sample.

4. Exact imitations of an adult's utterances are not included in the sample with the exception of greetings.

5. Exact self-repetitions are included for a maximum of three occasions. If repetition of the same utterance begins again after the other participant's turn in the discourse, it is included in the sample.

6. Stuttering is marked as repeated efforts of a single word. The word is counted once in the most complete form produced.

7. Fillers such as "oh," "um," or "mm" are not counted. "Oh" is counted when used as an acknowledgement; similarly "uh oh" is counted as one morpheme.

8. All compound words (two or more free morphemes), proper names, and ritualized repetitions count as single words. Examples include frenchtoast, hotdog, good-night, choo-choo, knock-knock. Social gestures also count as single words. Examples include excuse me, thank-you, you're welcome. Justification is that there is no evidence to suggest that the constituent morphemes function as such for these children.

9. All irregular past forms of the verbs are counted as one morpheme (got, did, went, saw). Justifiation is that there is no evidence that the child relates these to present tense forms.

10. All diminutives are counted as one morpheme (doggie, Mommy). Justification is that the children do not seem to use the suffix productively.

11. All auxiliaries (is, have, will, can, must, would) and all catenatives (gonna, wanna, hafta) are counted as single morphemes. All inflections are counted as separate morphemes (e.g. possessive -s, plural -s, third person singular -s, regular past -d, progressive -ing. Contracted forms are counted as one morpheme unless there is evidence of use of "not" as a separate morpheme.

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* adapted from Brown, 1973, p. 54.

Appendix D

Grammatical Morphemes*

Morpheme	Specific Form(s)
Present progressive	-ing
Plural (regular)	-s, -es, etc.
Past irregular	came, ran, etc.
Possessive	-'s
Uncontractible Copula	is, am, are
Past regular	-d, -ed, -/t/
Third person regular	-s, -/z/, etc.
Third person irregular	does, has
Uncontractible auxiliary	is, am, are
Contractible copula	-'s, 'm, 're
Contractible auxiliary	-'s, 'm, 're

* Adapted from Brown's (1973) grammatical morphemes

Appendix E

Category	Definition
Existence	Utterance makes reference to the presence of an object in the environment.
Nonexistence	Utterance makes reference to the absence of an object.
Recurrence	Utterance makes reference to the reappearance of an object.
Rejection	Utterance in which an object or action is refused.
Denial	Utterances which counter the truth value of another's comment.
Attribution	Utterance makes reference to the property or state of an object.
Possession	Utterance makes reference to ownership of an object.
Action	Utterance makes reference to action on an object by an agent or utterance makes reference to the actions of an agent or object.
Locative Action	Utterance makes reference to movement where the goal of the movement is to change the location of a person or object.
Locative State	Utterance makes reference to a person or object and it's location. No movement can be responsible for the location of the object either before, during or after the child has talked.
State	Utterance makes reference to an internal state, a temporary state of ownership, or an external state of affairs.
Quantity	Utterance designates the number of objects or persons either by use of a number word, plural -s inflection, or adjectives such as "some" or "many."
Time	Utterance makes reference to ongoing, imminent future or past time, either by use of grammatical morphemes such as -ing, -ed, irregular past tense verbs; adverbs of time, such as "now."
Notice	Utterances refer to atention to a person, object, or event and necessarily include a verb of notice (see or hear).

Coordinate	Utterances in which two independent events and/or states are bound together in space or time. The combination of the two utterances does not create a new meaning.
Causality	Utterances which have implicit or explicit cause and effect relationships between two verb relations.
Dative	Utterances which designate the recipient of an object or action with or without a preposition.
Specifier	Utterances which specify a particular person, object or events by contrastive use of the demonstrative pronouns "this" or "that" or the articles "a" or "the."
Epistemic	Utterances in which relationships between two states, or an event and a state, refer to certainty or uncertainty about event or state.
Mood	Utterances which express the attitude of the speaker about event by use of modal verbs such as "can," "should," or "must."
Antithesis	Utterances which express dependency between two events and/or states and the dependency is a contrast between them.
Vocative	Utterances which call or direct the attention of another.
Affirmation	Utterances in which an object or action is accepted.
Rituals	Utterances which are stereotypic and frequently used.

Appendix F

Definition of categories of speech acts*

Category	Definition
I. Comment	Communicative acts which identify or describe objects, actions, states, people, or events.
A. Comment on objects	Communicative acts which refer to the identity of or properties of objects (location, attribute) or make reference to an object or person association.
B. Comment Action/States	Communicative acts which refer to the actions or states of objects or of self. This category includes "symbolic" comments made within play schemes.
C. Comment on People	Communicative acts which refer to the identity or acton of people (other than self).
D. Comment on Events	Communicative acts which refer to the identity of events.
E. Comment to Self	Comments of any of the types described above which are said to self as indicated by volume and/or by nonlinguistic context.
II. Request	Communicative acts which solicit a nonlinguistic or linguistic response from another participant in the interaction.
A. Request Objects	Communicative acts which solicit a desired object that may or may not be in the child's proximity and may or may not be in the immediate context.
B. Request Action/Help	Communicative acts which solicit a desired action on an object or person.
C. Request Information	Communicative acts which solicit a linguistic response from another participant in thje interaction. These include requests for information about names of objects, location of objects, and nature of objects and events; requests for confirmation of child's actions, location of objects, and participant's attention; requests for permission.
D. RQ Direct Attention	Communicative acts which solicit the other participant's attention to an object or an activity.
E. Protest	Communicative acts which indicate that the child does not want to engage in an activity or does not want the participant to begin or continue an activity.

III. Routines	Communicative acts which are stereotypic or ritualized occasions of "talk" (vocalizations or verbalizations) or of gesture that accompany play activities.
A. Accompaniments	Communicative acts which are nonpropositional and accompany the child's play actions.
B. Play Talk	Communicative acts which are routinized examples of sounds or words associated with certain kinds of play schemes.
C. Greeting	Communicative acts which mark openings or closings in the interaction. These include greetings used within play schemes.
D. Politeness	Communicative acts which involve the explicit use of polite forms.
E. Social Game	Communicative acts which involve "playful" sequences of joint action or reciprocal action engaged in as a dyadic game.
F. Express Pleasure	Communicative acts which indicate that the child is please with some object or activity in the context.
G. Play Exchange	Communicative acts which engage, extend, or negotiate the play activity between two people.
IV. Discourse	Communicative acts which are identified relative to the previous speech act in that they are directly elicited by that act.
A. Acknowledgement	Communicative acts which are in response to a prior request for information or to a prior comment and which indicate agreement with or acceptance of the prior proposition.
B. Rejection	Communicative acts which are in response to a prior request for information or to a prior comment and which indicate that the child does not want the object, action, etc. being offered.
C. Response to Choice ?	Communicative acts which are in response to a prior either/or question.
D. RS to Clarification RQ	Communicative acts which are in response to a prior bid for clarification.
V. Undetermined (UD)	Communicative acts whose speech act function could not be determined either because the utterance was partially or totally unintelligible or because the function was equivocal.

*Gerber Wollner, S. (1985)

The Hearing Performance Inventory as a Tool for Assessing Hearing Aid Benefit

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James J. Dempsey*

Abstract

The purpose of this study was to determine if the Hearing Performance Inventory (HPI) is sensitive to changes in self-reported performance, due to amplification. The subjects were five hearing impaired adults with mild to moderate sensorineural losses. They completed an HPI both before being aided and six weeks following the date on which they received their hearing aids. Significant improvement in performance was revealed for the group averages in the Understanding Speech, Social and Intensity sections. Individual subject difference scores showed a great deal of variation between the subjects. The implications of these results in regard to adult aural rehabilitation programs is discussed.

Various methods have been used in the classification of hearing loss. Clark (1981) reviewed the problems and advantages associated with the more commonly accepted methods of hearing loss classification. Percentage classifications such as the American Academy of Ophthalmology and Otolaryngology (AAOO) method have proved to be beneficial for medical-legal cases where judgements of disability require an objective means of classification. However, percentage methods tend to underestimate hearing difficulty associated with high frequency hearing loss.

Another common method of hearing loss classification, the adjective descriptors, were also reviewed by Clark. These are the labeling or severity scales which classify hearing loss as falling within a range of severity, usually from mild hearing loss to profound hearing loss. A two-frequency or three-frequency pure tone average may be used to make these classifications. Because these adjectives descriptors utilize the pure tone averages, Clark found that they may not account for the effects of high frequency hearing loss. Further, as more than one of these labeling scales exist, classification in terms of severity based on adjective descriptors is not standardized.

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Individuals displaying similar audiometric configurations may vary greatly in terms of auditory difficulty experienced daily. The classification methods discussed by Clark account for hearing impairment rather than hearing handicap. An ASHA Task Force (Asha, 1981) was formed in 1978 in order to specifically define the terms "hearing impairment," "hearing handicap" and "hearing disability." Hearing impairment was defined as "a deviation or change for the worse in either auditory structure or auditory function, usually outside the range of normal." Hearing handicap was defined as "the disadvantage imposed by a hearing impairment on a person's communicative performance in the activities of daily living." Hearing disability was defined for use in cases of worker's compensation and, therefore, does not relate to the purpose of this paper.

Hearing handicap is the result of the interaction of many factors. The ASHA Task Force included among the factors: present age of the individual, age at onset of impairment, nature and extent of impairment, individual's communicative needs, individual's reaction and others' reaction to impairment and effect of impairment on expressive communicative ability (ASHA, 1981). Rosen (1979) summarized the results of several studies concerned with the effects of hearing handicap. In general, she found that hearing handicap increases proportionately with increases in hearing impairment.

Myklebust (1960) reported the results of a study in which hard of hearing adults were asked to answer six brief essays regarding their adjustment to hearing loss. Although statistical analysis could not be performed, general trends in response patterns were noted. Subjects reported greater dependence on family members, loss of friendships with the normally hearing, primary identification as a member of the hearing impaired community and a need to change occupations and/or hobbies. It should be noted that Myklebust's subjects were members of a Hearing Society and, therefore, may not have been a representative sample of the hearing impaired population at large.

In order to assess hearing handicap, a number of self-report scales have been developed. These scales, presented to hearing impaired clients, are questionnaires which attempt to assess the effects of the impairment on everyday life. The Hearing Handicap Scale (HHS) was developed by High, Fairbanks and Glorig (1964) in order to represent hearing handicap in terms of a single number percentage score. Two alternative forms were developed, each consisting of twenty questions. The questions used are similar to questions frequently employed informally by otologists and audiologists. The authors did not attempt to assess handicap in vocational or psychological domains. The value of the HHS, according to its authors, is that it allows for standardization of both the form of the questions and type of allowed response. Thus, hearing handicap can be quantified. A single-number, standardized score allows for comparison between individuals and within one client over time.

Speaks, Jerger and Trammell (1970) researched the relationship between HHS scores and measures of sensitivity loss and speech discrimination loss. Sensitivity for speech was measured using 50% thresholds for PB words, synthetic sentences in quiet and synthetic sentences in the presence of a competing speech signal. Speech discrimination was measured as the performance score using PB words at 40 dB SL at 1000 Hz, PB Max., PB words at 110 db SPL, a synthetic sentence presented at 110 dB SPL. The investigators found that the HHS correlates much higher with measures of sensitivity loss rather than discrimination. Thus, they concluded that HHS items are responsive to loss of sensitivity rather than discrimination.

Giolas (1970) claimed that the items on both forms of the HHS are narrow in content and homogenous. Further, Giolas criticized the HHS for the absence of items needed to assesss speech discrimination, vocational status and general attitude toward handicap.

The Social Hearing Handicap Index (Ewertsen and Birk-Nielsen, 1973) was developed following the principles of High, Fairbanks and Glorig. However, the authors attempted to balance out clients' potential stereotyped answering biases. As opposed to the five possible responses found in the HHS, the SHI allows only for "yes," "no" and "I don't know." Ewertsen and Birk-Nielsen found a high, positive correlation between speech reception thresholds and SHI. Individuals with slight degrees of impairment demonstrated a greater range of variability on SHI scores. Use of the SHI, however, is limited as it is available only in Danish.

The Hearing Measure Scale (Noble and Atherley, 1970) was devised to assess handicap due to cochlear, sensorineural lesions. The HMS, a controlled interview format scale, was developed in an attempt to improve on design of the HHS. High, Fairbanks and Glorig noted that the original test sample used for the HHS was not controlled in terms of the type of hearing disorder. They suggested that the majority of subjects had mixed losses with a predominate conductive component. Noble and Atherly, therefore, developed the HMS for sensorineural populations. Subjects used in the HMS study were men employed in noisy occupations. The authors found the HMS to be a consistent measure of hearing impairment and hearing handicap. The HMS includes sections on non-speech sounds, emotional response to hearing impairment and personal opinion of hearing impairment. Thus, its scope is somewhat broader than the HHS or the SHI. However, this scale may only be applicable to clients suffering from noise-induced losses and not individuals with sensorineural loss as a whole.

The Hearing Performance Inventory (Giolas, Owens, Lamb and Schubert, 1979) was developed to assess performance in everyday listening situations. The self-report questionnaire consists of six sections: (1) Understanding Speech, (2) Intensity, (3) Response to Auditory Failure, (4) Social, (5) Personal and (6) Occupational. The HPI is intended to provide a detailed analysis of each individual's communicative breakdown, a measure of performance for assessment and a measure by which to judge progress. The original profile consisted of 158 items. Administration time was approximately one hour. The five responses, ranging from "practically always" to "almost never" are assigned numerical values of 1 to 5. Percentages scores are tabulated and converted into profiles for each section individually and for the client as a whole.

Lamb, Owens and Schubert (1983) reported that feedback on the HPI revealed that it was repetitious and time consuming. Hence they revised the original form and administered a ninety item HPI to 354 subjects drawn from a typical caseload of a community audiology clinic. Statistical analysis of the results showed reliability to be high for all sections except for the Response to Auditory Failure subsection of the Occupational section. Item-total correlations revealed disparities between the sections. The authors recommended that the sections of the HPI be treated individually except for the Understanding Speech and Intensity sections. These two sections correlated highly with responses on the inventory as a whole and are, therefore, useful in assessing degree of impairment.

The self-report scales discussed above have been proven useful in assessing some aspect of hearing handicap. Several authors (Giolas, 1979; High, Fairbanks and Glorig, 1964) suggest the use of these scales to assess progress following remediation. Tannahill (1979) investigated the use of the HHS in measuring hearing aid benefit for 24 hearing impaired adults with sensorineural losses of 5 dB HL to 55 dB HL. HHS scores, word identification scores and speech reception thresholds were obtained prior to hearing aid use and four weeks following hearing aid use. The results revealed that although SRT's improved with amplification, this did not correlate highly (.37) with self-reported improvement on the HHS. The correlation between word discrimination improvement and HHS ratings was higher (.74). The author concluded that improvement in discrimination was related to self-reported improvement in daily listening. On the basis of these test results, Tannahill claimed that the HHS is a valid tool for assessing hearing aid benefit. The discrepancy between improved SRT's and self-reported improvement was attributed to the fact that many of the subjects had mild losses or losses in the high frequencies only. For such clients, improved SRT scores are less important than improved discrimination, and sometimes undesirable.

Owens and Fujikawa (1980) used the HPI to measure hearing aid benefit in the profound hearing loss population. Thirty subjects with acquired hearing losses of 80 dB or more were administered the unrevised form of the HPI. The subjects were placed into two groups:
(1) those using hearing aids versus those not using hearing aids and,
(2) aided subjects with losses greater than 100 dB HL versus subjects using hearing aids with losses of 80 to 100 dBHL. Results indicated that hearing aids were beneficial to the profoundly hearing impaired subjects. Subjects who were hearing aid users reported performing better in all situations compared with unaided subjects. Aided subjects with losses of greater than 100 dB consistently scored higher (showed greater difficulty) than those with losses under 100 dB. Thus, subjects with greater losses may not benefit as much from hearing aids as those with lesser losses. These results were consistent in all sections of the HPI except for the Personal items and the Response to Auditory

Failure items. These items failed to differentiate between subjects in either group comparison. The authors concluded that the HPI may be a valuable tool in hearing aid assessment. They suggested the use of the HPI before and after aiding clients to assess amplification benefits.

In summary, standard methods of classifying hearing loss have proved to be inadequate measures of hearing handicap. Several self-report scales have been developed in order to assess degrees of handicap. It has been suggested that these scales may be used to determine hearing aid benefit. The HPI was designed to assess handicap in a large variety of communicative situations. It has been proven to be a valuable tool for the assessment of hearing aid benefit in a profound hearing loss population.

The purpose of this study was to determine if the HPI is sensitive to subtle changes in individuals' self-reported performance due to amplification. Because the HPI was designed to assess communicative performance in a variety of parameters, the authors of this study expected improvement to be the greatest in those areas directly related to amplification. It was hypothesized that the Intensity and Understanding Speech sections would reveal the most significant improvement.

Method

Subjects

Five adult subjects with mild to moderate bilateral sensorineural hearing losses were studied at the Queens College Speech and Hearing Center. They were selected on the basis that they were non-hearing aid users at the time of their initial hearing evaluations. Four of the subjects were male and one was a female. They ranged in age from 49 years to 77 years; with a mean age of 65.

Procedure

Subjects were administered the revised form of the HPI at the time of their initial hearing evaluations or prior to receiving their hearing aid. Four of the subjects received their hearing aids directly from this center. The other subject purchased his hearing aid elsewhere. All of the subjects were seen for follow-up visits which included hearing aid orientation, in order to insure proper hearing aid use.

The second HPI was re-administered at approximately six weeks following the date on which each subject received his/her hearing aid. The results of an accompanying user satisfaction questionnaire and personal interviews insured that all of the subjects were using their hearing aids on a daily basis and were generally satisfied with them.

Scores for the following five sections of the HPI were obtained: Understanding Speech, Social, Response to Auditory Failure, Intensity and Personal. Scoring was achieved by assigning numerical values to the five descriptive responses. For example, a response of "practically always" was assigned the numerical value of 1. A response of "about half the time" was assigned the value of 3. "Almost never" was assigned the value of 5. A section score having a value of 5 suggests maximum difficulty. A section score having a numerical value of 1 suggests very little difficulty in that area. Sections scores falling between these two extremes reveal varying degrees of hearing performance difficulty.

Results

Each individual subject's pre-test and post-test questionnaires were scored according to the method described in the "procedure" section. Results were analyzed for individual subjects, as well as for group averages. Of primary concern for this study was the difference score (pre-test score minus post-test score) across the five sections.

When employing self-report procedures, it is necessary to estimate the standard error of measurement (Demorest and Walden, 1984). Standard error of measurement (Se) may be considered as the standard deviation of independently obtained scores around a subject's true score. This measure is important as it allows us to consider internal consistency, reliability and standard deviation, as well as providing us with a confidence interval for a subject's true score. An Se provides a measure of the accuracy of an individual subject's score independent of the variability among subjects. Se may be obtained using the formula provided by Demorest and Walden (1984):

Formula 1: $Se = Sx \quad 1-rxx'$ (where Sx is the standard deviation and rxx' is the reliability coefficient.

However, when assessing the difference between scores obtained on two occasions, true change must be determined by considering the measurement error of both scores. Thus, the standard error of measurement for a pre-test - post-test difference score is obtained by:

Formula 2: $(X2 - X1) + 2 \quad 2\ Se$.

Using this formula allows us to conclude with a 95% confidence interval whether or not a true change has occurred. For the purpose of this study, the Se value were taken from Demorest and Walden (1984) using data which they obtained by administering the HPI to 250 subjects. Using these values in Formula 2, we arrived at our own values for minimum, significant difference.

Group average data is provided in Table 1. Average scores for the pre-test, post-test and average difference scores are provided, as well as the significant minimum difference (obtained using Formula 2) for each of the five sections.

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Table 1. Group average scores for pre and post test.

	Pre-test	Post-test	Average Difference	Significant Minimum Difference
Understanding Speech	2.36	1.67	.68	.27
Response to Auditory Failure	2.72	2.72	.10	.51
Social	2.43	2.06	.37	.37
Intensity	2.78	1.93	.85	.59
Personal	1.99	1.68	.31	.93

Results in Table 1 indicate that significant improvement in self reported performance for the group occurred in the Understanding Speech, Social and Intensity sections. Changes in the Response to Auditory Failure and Personal sections were not significant. It should be noted that the change in the Social section (.37) is exactly equal to the significant minimum difference for that section. However, the average difference scores for Understanding Speech and Intensity greatly exceed the significant minimum differences. These results reveal that the most significant improvement occured in those categories where improvement due to amplification was expected. For the group, improvement in the Intensity and Understanding Speech sections supports our hypothesis.

The differences for individual subjects for each section are shown in Table 2.

Table 2. Differences for individual subject's on each section.

	Understanding Speech	Response to Auditory Failure	Social	Intensity	Personal
Subject 1	.55	1.14	.36	.91	.83
Subject 2	1.27	-.14	.95	.90	.40
Subject 3	.78	.54	.66	1.76	1.34
Subject 4	.47	-.67	-.15	.46	-.83
Subject 5	.40	-.37	.01	.21	-.17
Minimum Difference Scores	.27	.51	.37	.59	.93

Although the group data supports the stated hypothesis, examination of individual subject data reveals intersubject variation. While the group as a whole exceeded the minimum significant difference in the Intensity section, subjects 4 and 5 both had pre-test post-test difference scores below the minimum significant difference. Subject 3, however, revealed greater change in the Intensity and Personal sections than any other subject. A wide variation in difference scores was present in all five sections.

Discussion

Data obtained from group averages (see Table 1) supports the hypothesis that improvement was revealed in the areas of Understanding Speech and Intensity. As the purpose of a hearing aid is to amplify sound, one would logically conclude that responses to questions aimed at assessing how well a subject detects environmental sounds will improve following hearing aid use. Questions in the Intensity section were designed to assess response to environmental sounds such as soft speech, public address systems, television and radio, as well as non-speech sounds such as doorbells, music, telephone ringing, etc. It is therefore not surprising that following hearing aid use, responses to Intensity questions improved.

When speech is amplified for the hearing impaired client, one hopes that the spoken message becomes easier to understand. The term "understanding" was defined in the HPI instruction sheet as "hearing the words a person is saying clearly enough to be able to participate in the conversation." Therefore, while the Intensity questions assess detection of sound, Understanding Speech questions assess comprehension. Again, one would expect this area to improve following hearing aid use. As both of the sections related to amplification revealed improvement for the group average, it can be concluded that the HPI is a sensitive tool for detecting improvement following amplification.

Group results revealed borderline improvement in the Social section. Questions in the Social section are comprised of items taken from the Understanding Speech and Response to Auditory Failure sections which assess performance in group conversational situations (Lamb, Owens and Schubert, 1983). Thus, the borderline change may be the result of the non-significant change in Response to Auditory Failure coupled with the significant change in Understanding Speech. Further, as the Social questions assess group conversation, the introduction of a hearing aid may have provided some assistance to the subjects.

Questions from the Personal section assess the respondent's feelings about his/her hearing loss. Response to Auditory Failure items assess how often subjects engage in certain behaviors to compensate for hearing impairment (Lamb, Owens and Schubert, 1983). Response to Auditory Failure items include: asking for assistance, asking for a repetition, pretending to understand, adjusting the hearing aid, etc. According to Giolas, Owens, Lamb and Schubert (1979), items from the Personal section deal with a respondent's self-esteem. Response to Auditory Failure items access behaviours which either enhance or detract from communicative efficiency. No significant change in hearing handicap was revealed in these two sections.

Since the HPI is a sensitive tool for assessing hearing aid value, it is possible that benefit to those areas assessed in the Personal and Response to Auditory Failure items may require more than merely providing clients with amplification. For example, an aural rehabilitation program may include hearing aid orientation during which the limitations, as well as the benefits of hearing aids are discussed. The client may then be made aware of what compensatory behaviors (such as those assessed by the Response to Auditory Failure items) must be used to supplement amplification. Thus, using the HPI as an assessment procedure for a comprehensive rehabilitative program will provide the audiologist with a global profile of an individual's strengths and weaknesses. From this, a more complete program can be planned. Difficulties in the Personal and Response to Auditory Failure sections, once identified, will provide the audiologist with a groundwork from which he may begin to provide appropriate counseling. According to Lamb, Owens and Schubert (1983), "the sensitivity (of the items in the Personal section) renders them most useful for discussion purposes in a rehabilitative context."

Examination of the individual data (see Table 2) reveals wide variation between the five subjects. Despite significant group improvement in the Intensity section, subjects 4 and 5 both revealed less than significant change in that area. Further, these two respondents revealed the least amount of improvement. Subject 4 yielded the greatest amount of negative difference scores. This subject's Response to Auditory Failure deteriorated markedly. Despite these results, Subject 4, through personal interviews and written statements, claimed to be a satisfied hearing aid user. However, the only area where he demonstrated significant improvement was in Understanding Speech. For moderately impaired clients like Subject 4, the primary goal in amplification is to make speech louder so that it may be understood. This goal is likely to be far more important than the awareness of simple environmental sounds (Intensity section).

Subject 4's difference scores provide us with an example of the value of a comprehensive self-report scale, such as the HPI. Using this scale before and after aiding, helps the clinician identify which areas need work. For example, Subject 4's Response to Auditory Failure worsened. Response to Auditory Failure items assess the frequency of behaviors used to compensate for hearing loss. It can be hypothesized that Subject 4 was using desired behaviors (asking for repetition, informing others of hearing loss, etc.) more frequently and using undesirable behaviors (pretending to understand) less frequently before he was aided than after. Perhaps this subject was not counseled as to the limitations of his hearing aid. It is possible that this subject was relying too heavily on his hearing aid. In a situation where a communicative breakdown occured, he no longer used appropriate compensatory behaviors. Clearly, this subject needed to be counseled in order to understand limitations of his hearing aid and to learn behaviors which would supplement the hearing aid.

In contrast to Subject 4, Subject 3 showed significant improvement in all five sections. Like Subject 4, Subject 3 claimed to be a satisfied hearing aid user and his HPI difference scores proved it. This subject has benefited, in every aspect, from his hearing aid and in contrast to Subject 4, minimal counseling should be required.

When planning an aural rehabilitation program for an individual client, a detailed analysis of each HPI section may be appropriate. For example, Understanding Speech can be broken down into: talker (male, female, child, stranger, etc.), noise environment (quiet, music, people talking nearby), presence or absence of visual cues, etc. Thus, particular areas of difficulty under specific communicative situations can be identified and can provide the basis for an individual program of aural rehabilitation.

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Asymmetry in the Latency-Intensity and Amplitude-Intensity Functions of the Brain Stem Evoked Responses of Normal Hearing Subjects

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Abstract

The area of brain stem evoked response (BSER) audiometry has had considerable research for clinical use in the past decade. The presence of interear asymmetry has recently received attention in the literature, with little research to determine the significance of this phenomenon. This study attempted to determine whether there was a significant asymmetry in the latency and amplitude of right and left BSERs of fifteen normal hearing males and females. Results indicated that the frequency of interear asymmetries occurring in peak latency and amplitudes was significantly above chance. Furthermore, the frequency of these asymmetries changed with stimulus level.

In recent years there has been a widespread interest in the clinical utilization of brain stem evoked responses (BSERs) elicited by auditory stimulation. The auditory brainstem evoked response was first described by Jewett and Willingston in 1971 as "far-field" recordings of neuroelectric activity within the brainstem auditory pathways (Jewett and Williston, 1971). An introduction to BSER audiometry and a presentation of issues relating to this study will be discussed in two parts.

The Brain Stem Evoked Response.Brief auditory stimuli, such as clicks, elicit a sequence of seven vertex-positive waves occuring within the first ten milliseconds after stimulus onset, and can be recorded from the human scalp. These waves are generated by neural structures within the brain stem, and are consistent from one subject to the next (Jewett and Williston, 1971; Picton, et.al., 1977). The generators of these waves have been roughly identified as the following: Wave I - VIIIth nerve, Wave II - cochlear nuclei (now also thought to be from the VIIIth nerve), Wave III - superior olivary complex, Wave IV - lateral lemniscus, and Wave V - inferior colliculus (Buchwald & Huang, 1975). Wave VI and VII are thought to arise from the medial geniculate body and the thalamo-cortical areas, respectively, but these do not appear consistently in all subjects.

Waves I, III and V have been found to be the most reliable and reproducible peaks. The transmission times of these waves appear to be

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the most clinically useful measurements (Rowe, 1978). Wave V, however, is the most robust and prominent wave and remains identifiable at stimulus levels near threshold, while earlier waves often become obscured by background noise.

There is an inverse relationship between latency of the waves and intensity of the stimulus (i.e. as intensity of the stimlulus increases, the latency of the waves decreases). There is, on the other hand, a direct relationship between stimulus intensity and peak amplitude. An increase in the intensity of the stimulus causes an increase in the amplitudes of the BSER components (Picton, et.al., 1974). The relationship between latency and intensity, or amplitude and intensity can be plotted as a graph. The graphs are known as the latency-intensity function and amplitude-intensity function, respectively.

The latency-intensity (L-I) function depicts the way in which the wave latencies change with stimulus intensity. An average L-I curve can be generated for normal hearing individuals. By comparing a hearing impaired person's L-I curve to the normal curve, the extent and site of lesion of the hearing impairment can be determined. For example, a latency-intensity curve which parallels, but is displaced from the normal curve is indicative of a conductive hearing loss. A sensorineural hearing loss shows "a rapidly changing wave V latency-intensity curve, which eventually intersects and joins the normal range of values" (Galambos & Hecox, 1978). Patients with acoustic neuroma show a change in the slope of the L-I function, along with other abnormal characteristics (Galambos & Hecox, 1978; Seltzers & Brackmann, 1977).

The amplitude-intensity (A-I) function is determined from the way in which the wave amplitudes change with stimulus intensity. The A-I functions are not used clinically because absolute amplitude has been shown to be too variable a measure, both inter- and intra-subject, to be useful as a clinical tool (Rowe, 1978).

BSER contains information which aids the clinician in distinguishing between retrocochlear and cochlear pathology (Galambos and Hecox, 1978; Seltzers and Brackman, 1977; Daly, et.al., 1977). Diagnostic information can be obtained from the pattern of the BSERs. Seltzers and Brackman (1977), have noted several abnormal characteristics, in BSER, for patients with acoustic neuromas. Delays in the wave V latency, abnormal interpeak latency, abnormal interaural latency differences, or the absence of wave V, are among the findings which are typical of retrocochlear or brainstem pathology.

Brain stem evoked response audiometry is an objective test for estimating hearing sensitivity which is essentially unaffected by subjective changes (i.e. emotion) or medication (Picton, et.al., 1977). The audiologist is now presented with an excellent method of estimating the hearing of those who previously could not be tested by behavioral means (Picton, et.al., 1977; Galambos and Hecox, 1978; Fria, 1980). Most important in this category is the pediatric population.

Although asymmetry has in the past, been considered a sign of auditory abnormality (Seltzers and Brachmann, 1977), recently significant right/left asymmetries have been reported in the brainstem responses of normal subjects (Rowe, 1978; Chiappa et. al 1979; Decker and Howe 1981; Spivak and Sietz, 1984). While the functional significance of these asymmetries is unknown, there has been some speculation that they may be related to higher level asymmetries which are known to exist in the central auditory nervous system.

Asymmetry in CANS. Asymmetries have been identified in the central auditory nervous system (CANS). The best documented asymmetries are those related to language function. In dichotic listening tasks of, Kimura (1961) reported the right ear advantage, which was attributed to the dominance of the left hemisphere for speech processing. In a study of hemispheric specialization for speech perception, Studdert-Kennedy and Shankweiler (1970) have suggested that "while the general auditory system may be equipped to extract the auditory parameters of a speech signal, the dominant hemisphere is specialized for the extraction of linguistic features from those parameters" (Pg. 592-3). This is attributed to the prepotency of the contralateral auditory pathway to the language-dominant left hemisphere. Non-linguistic, auditory asymmetries, however, have also been documented. In a study of the perception of melodies, Kimura (1964) reported a left ear advantage related to a right hemispheric dominance for processing of non-linguistic sounds.

Since the auditory evoked potentials represent neuroelectric activity within the central auditory nervous system (CANS), some researchers have sought to find asymmetries in the auditory evoked potentials, analogous to ear asymmetries which are apparent during dichotic listening tasks.

Studies of the late cortical evoked responses have attempted to demonstrate CANS asymmetry, however, these have led to conflicting results (Grabow & Elliott, 1974; Morrell & Salamy, 1971). Ruhm (1971), on the other hand, in his study of lateral specificity of click-evoked responses, found a right hemisphere dominance (left ear advantage), when non-verbal, non-meaningful stimuli were presented.

In a study of middle latency responses (MLR), Peters and Mendel (1974) reported no consistent differences in latency or amplitude of the right and left ear responses for their subjects. However, Hood, et.al. (1983) noted significant difference in the absolute latency of wave Pb when the MLR of right and left handed listeners were comparent. Asymmetries found in responses to right monaural stimulation as compared to left monaural stimulation were present for both the MLR and late potentials.

Until recently, researchers have not reported significant right-left differences in BSER (Starr & Squires, 1982; Dobie, 1982; Dobie & Norton, 1980; Ainslee & Boston, 1980). This is due to the fact that mean data were analyzed in which small R-L differences may cancel (Decker & Howe, 1981). When individual data are examined, however, small, consistent R-L differences can be found.

Chiappa, et.al. (1979) recorded BSERs in 50 normal adult subjects at various click rates. These researchers studied normal variations in the morphological patterns of their recordings to monaural click stimulus. Several variables were studied, including absolute latencies, interwave latencies, absolute amplitudes and amplitude ratios. These response parameters were first measured for individual ears. Six different patterns of the wave IV-V complex were seen in the 50 normal subjects tested. It was found that almost half (42%) of the subjects had patterns which differed between their two ears. The wave V amplitude differences between the two ears also suggested an asymmetry. Based on these results, Chiappa, et.al. (1979) concluded that BSERs should be recorded monaurally as opposed to binaurally, in order to determine whether there is an abnormality in the brain stem response.

Rowe (1978) investigated the normal variablitiy of the brain stem evoked response in 25 young and 25 old subjects with normal hearing. Upon analysis of the waveforms, there were found marked morphological differences between the two ears of many of his subjects. Evaluation of mean peak latencies, for both ears combined, showed no statistical differences for left and right ear responses. However, when individual subjects, were observed, there were interear latency differences of up to 0.4msec. for waves I through V in 95% of the subjects.

Levine and McGaffigan (1983) studied right-left asymmetries in the brain stem evoked response of 32 normal subjects. Though significant interear latency differences were not found, they did find asymmetries in the amplitudes for waves III, IV, and negative though following wave I.

Studies of binaural interaction have also revealed response asymmetries. Spivak and Seitz (1984) found 71% of their subjects demonstrated right/left response asymmetries. Allen, et.al. (1982) noted 44% of their subjects showed asymmetry when stimuli were presented diotically.

Recently, Decker and Howe (1981), in an investigation of binaural interaction, reported no significant differences in wave V for the right and left ears when mean data were examined. Asymmetry favored either the right or left and, therefore, cancelled when mean data were analyzed. However, examination of individual data revealed that small R-L asymmetries had a pronounced effect on their measure of binaural interaction. These asymmetries were found in 50% of their subjects. It was, therefore, suggested that data be examined on an individual basis and not on a mean or group basis due to the tendency for asymmetries to cancel when group data is examined.

The studies presented here have examined the subject of asymmetry in BSER. Many factors, such as interear differences in wave morphology, latency and amplitude were discussed. No published study, to date, has explored asymmetry as a function of stimulus intensity. Therefore, this study examined normal response asymmetry as a function of stimulus intensity. The main purpose of this study was to determine if there was a difference in the latency-intensity and/or amplitude intensity functions between the two ears. Observations from previous pilot work suggests that these differences occur in some subjects (Spivak and Seitz, 1984; Decker, 1985). Up until now, there have been no published studies to confirm these observations.

It was hypothesized that there are interear asymmetries in BSER which will manifest themselves as significant differences in the amplitudes and/or latencies between two ears, in spite of equal hearing and equal dBSL stimulation. It was further hypothesized that the frequency of asymmetry will change as a function of stimulus intensity. Latencies of waves I, III and V and amplitudes of wave V were selected for analysis.

Method

Subjects

Fifteen normal hearing subjects (5 male, 10 female) participated in this study. Subjects ranged in age from 20-32 (Mean age = 25). Subjects were selected according to the following criteria: normal, symmetrical hearing with no interear threshold differences exceeding 5dB at any frequency.

Apparatus

A Grason-Stadler Instruments - 10 audiometer was used for audiometric screening of subjects. A Cadwell Brain Stem Response audiometer, Model #5200, employing TDH-39 earphones was used to record the BSER.

Procedure

Each subject was given a pure tone threshold test, using the standard Hughson-Westlake method, to determine eligibility to participate in this experiment. Once this was established, the subject was given a brief description of the procedures. Tin-cup electrodes were attached to the vertex (reference), right and left mastoids (active) and forehead (ground) . Electrodes were attached with conductive paste and surgical tape. Electrode impedances were maintained within the range recommended by the manufacturer.

Subjects reclined on a comfortable cot with eyes closed. Earphones were placed over the ears. Behavioral click threshold was determined for each ear using an ascending-descending procedure. Stimuli were presented monaurally to each ear. Clicks were delivered at a rate of 11/sec. Intensities used were 70, 50 and 30dBSL. Responses to 2048 clicks, at each stimulus level were averaged. Each run was replicated. The same earphone was used for each ear to control for earphone differences.

The latencies of waves I, III, and V, and the amplitudes of wave V were measured on line using the Cadwell cursors. A hard copy was made of all the waveforms. The latency-intensity functions for waves I, III, and V were determined for each subject. The amplitude-intensity function for wave V was also determined.

Criterion for significant asymmetry was determined in the following manner: The null hypothesis established for this study was that right measurements (latency in msc. and amplitude in microvolts) minus left measurements would not exceed the run to run variability which would be expected due to rancom background noise (i.e. Right measurement - Left measurement = Run 1 measurement - Run 2 measurement). Criterion was established by estimating the error term in the measurements for each subject (Levitt, 1985) This was done by measuring the variability in each measurement for each subject (Run1 - Run2). The standard error of the mean was calculated for each measurement and was used as the criterion. Asymmetry was defined as any right minus left measurement exceeding criterion. If R-L differences exceeded the criterion, then the null hypothesis could be rejected at the .05 level of confidence.

Results

Comparisons were made between right and left latencies for waves I, III and V and right and left amplitudes for wave V. The mean and standard deviation for each of these measurements are presented in Tables 1 and 2.

Table 1. Mean latencies and standard deviation of the right ear responses.*

Intensity (dBSL)		I		III		V	
		X (ms)	S.D.	X (ms)	S.D.	X (ms)	S.D.
70	R	1.80	(.10)	3.85	(.27)	5.76	(.28)
	L	1.76	(.13)	3.90	(.21)	5.84	(.30)
50	R	2.49	(.39)	4.48	(.38)	6.35	(.31)
	L	2.46	(.28)	4.57	(.36)	6.44	(.34)
30	R	---	---	5.31	(.31)	7.26	(.40)
	L	---	---	5.44	(.31)	7.39	(.42)

*Wave I was not measured at 30dBSL since it was not consistently identifiable at this low intensity level.

Table 2. Mean amplitudes and standard deviation of right and left responses for wave V.

Intensity (dBSL)	Right		Left	
	X (V)	S.D.	X (V)	S.D.
70	.42	(.20)	.40	(.15)
50	.40	(.15)	.35	(.10)
30	.35	(.13)	.31	(.11)

After criterion for right/left response asymmetry was established, the Binomial test was performed to determine if the number of subjects meeting criterion for asymmetry was significantly above the number that might be expected to occur by chance. Results revealed that the frequency of latency and amplitude asymmetry found was significant at the .05 level of confidence at each intensity level. The percent of asymmetrical subjects and confidence intervals are reported for each wave at each intensity level in Tables 3 and 4.

Table 3. Confidence intervals for frequency distributions of asymmetrical subjects (latencies).

SL	Wave	Proportion Asymmetrical	S.D.	95% Confidence Intervals
70dB	I	.29	.120	.03 to .55
	III	.53	.129	.26 to .80
	V	.47	.129	.20 to .74
50dB	III	.40	.127	.13 to .67
	V	.33	.121	.07 to .59
30dB	III	.45	.129	.18 to .72
	V	.47	.129	.20 to .74

Table 4. Confidence intervals for frequency distributions of asymmetrical subjects (wave V amplitude).

SL	Proportion Asymmetrical	S.D.	95% Confidence Intervals
70	.40	.127	.13 to .67
50	.27	.115	.03 to .51
30	.27	.115	.03 to .51

A McNemar test for significant difference between proportions was performed to determine whether there was significant difference between the frequency distributions of the asymmetries for each wave as a function of intensity. No significant differences were found (p>.05).

It was found that the classification of an individual subject's responses as symmetrical or asymmetrical changed as a function intensity and also as a function of the wave selected for analysis. In analysizing latency amplitude asymmetries for each wave as function of intensity, eight patterns emerged. Tables 5, 6 & 7 show the number of subjects demonstrating each pattern type. For example, in Type III, two subjects had significant asymmetrical responses at 70dBSL, but at 50dB and 30dBSL, the responses were symmetrical.

Table 5. The number of subjects exhibiting each pattern for wave V latencies at each intensity level.

		Intensity (dBSL)		
Type	# of Subjects	70	50	30
I	4	S*	S	S
II	3	A	A	A
III	2	A	S	S
IV	1	A	A	S
V	1	A	S	A
VI	3	S	S	A
VII	1	S	A	S
VIII	0	S	A	A
	(N= 15)			

*S=Symmetrical; A= Asymmetrical

Table 6. The number of subjects exhibiting each pattern for wave III latencies at each intensity level.

Type	# of Subjects	Intensity (dBSL) 70	50	30
I	3	S	S	S
II	2	A	A	A
III	1	A	S	S
IV	2	A	A	S
V	1	A	S	A
VI	1	S	S	A
VII	0	S	A	S
VIII	1	S	A	A
	(N=11)			

Table 7. The number of subjects exhibiting each pattern for wave V amplitudes at each intensity level.

Type	# of Subjects	Intensity (dBSL) 70	50	30
I	7	S	S	S
II	1	A	A	A
III	3	A	S	S
IV	1	A	A	S
V	1	A	S	A
VI	0	S	S	A
VII	0	S	A	S
VIII	2	S	A	A

Discussion

The results of this study show that the frequency of observed latency and amplitude asymmetries, occurring among normal hearing subjects, was significantly above chance. The percentages of asymmetries reported in this study were consistent with the percentages reported in many of the studies previously reviewed

(Chiappa, et.al., 1979; Decker and Howe, 1981; Allen, et.al., 1982; and Rowe, 1978). Asymmetries occur in approximately 40-50% of the total subjects in each experiment. Previous experiments, however, either used only one intensity level or did not report the effect of varying intensity on the frequency of asymmetry.

Changes in the BSER are known to occur as a result of stimulus level; latency increases as intensity decreases and amplitude decreases as intensity decreases. Rowe (1978) also reported that the wave shape is altered considerably by change in stimulus intensity. It was noted in the present study, that the percentage of asymmetrical subjects varies with the intensity level. For example, at 70dBSL for the wave V latency measurement, 47% of the subjects were asymmetrical, whereas 33% of the subjects were asymmetrical at 50dBSL.

Patterns of asymmetry in the latency-intensity and amplitude-intensity functions were also noted in this study (Tables 5-7). The result of the right ear measurement minus the left ear measurement for each subject, at each intensity level, was used to determine the patterns of asymmetry. Eight patterns were found, with different subjects exhibiting different patterns. Some subjects, for example, exhibited a Type VI pattern where the response of the right and left ear was symmetrical at 70dB and 50dBSL, but became asymmetrical at 30dBSL, while others exhibited a Type III pattern where the response of the right and left ear were asymmetrical at 70dBSL, but became symmetrical at 50dB and 30dBSL. No consistent pattern, however, was found across peaks within an individual.

Researchers have used a variety of measurements in determining the presence of response asymmetry. For example, Rowe (1978) and Seltzers and Brackmann (1977) used peak latencies. Levine and McGaffigan (1983), on the other hand, used an interear difference in baseline to peak amplitude measurement for determining asymmetry. Decker and Howe (1981) employed a, "technique whereby left and right monaural waveforms were subtracted individually from the binaural waveform to produce a difference trace" (Pg. 1084).

The results of the present study indicate that reports of the presence or frequency of asymmetry will vary depending upon the operational definition of asymmetry. For example, on the basis of this study, if significant interear wave V amplitude differences constituted the definition of asymmetry, then at 30dBSL, 27% of the subjects in this study would be considered asymmetrical. On the other hand, if interear wave V latency differences constituted the definition of asymmetry, at the same intensity level, 47% of the subjects would be considered asymmetrical. Asymmetry will also vary depending upon which peak is being considered. In considering wave V latency at 70dBSL compared to wave III latency at 70dBSL, the percentage of asymmetrical subjects changed from 47% in the first measurement to 53% in the latter.

The frequency of asymmetry will also vary with criterion used. For example, according to Seltzers and Brackmann (1977), an interaural time difference greater than .4msec in the wave V latency between the right and left ears of an individual was significantly asymmetrical. When comparing the subjects in the present study to the criterion established by Seltzers and Brackmann (1977), only three subjects would have been considered asymmetrical. Thus, use of the Seltzers and Brackmann criterion would result in a much lower percentage of asymmetrical subjects as compared with the percentage found in the present study.

Asymmetry has been used as a measure of brainstem abnormality. Seltzers and Brackmann (1977), as mentioned above, considered an interear difference in wave V latency (It5) greater than .4msec significantly asymmetrical and indicative of auditory brainstem abnormality. In the present study, three normal subjects exceeded the .4ms criterion and, therefore, would have been considered abnormal by Seltzers and Brackmann's standards.

Interear asymmetries in the latency-intensity and amplitude-intensity functions appear to represent normal variability among subjects. The presence of latency or amplitude asymmetry, therefore, may not be a useful indicator of abnormality, as Chiappa (1979) concluded for morphological asymmetry. The need to establish normative values for response asymmetries, taking into consideration the criterion used, and the various ways of measuring asymmetry, should be an incentive for future research.

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The Effect of Head Size
on the Auditory Brainstem Response

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Abstract

This study looked at head size in relation to the latencies of wave V and the I-V interpeak interval of the Auditory Brainstem Response. Twenty-two normally hearing men and women served as subjects for this study. Results suggest that head size is a factor to be considered in using ABR to make differential diagnosis.

Auditory Brainstem Response (ABR) Audiometry was designed to test people who are difficult to test by conventional methods. In addition, it is used as a site-of-lesion test to tap the possibility of retrocochlear pathology (Starr and Achor, 1975). The first to record ABR's from humans were Jewett, Romano, and Williston (1970). Jewett et al. described the normal ABR as consisting of seven waves which they designated in Roman Numerals. Wave V is the largest of the waves and the easiest one to recognize. Each wave represents neurological activity at successive sites along the auditory pathway. Although there is no complete agreement on the site represented by each wave, Buchwald and Huang (1975) suggested the following scheme:

Wave	Site
I	VIII Nerve
II	Cochlear Nucleus
III	Superior Olivery Complex
IV	Lateral Lemniscus
V	Inferior Colliculus

The site of waves VI and VII are higher up in the central auditory pathway. The exact location is either disputed or unknown. Stockard, Stockard, and Sharbrough (1977) suggest wave VI to be generated at the site of the Medial Geniculate and wave VII to possibly be generated at the Auditory Radiations.

The difference in time between the elicitation of a stimulus and the response to that stimulus is called absolute latency (Fria, 1980). The ABR occurs within ten milliseconds after the ear is stimulated by clicks and the waves are unaffected by sleep, sedation, or a person's state of awareness (Picton, Hillyard, Krausz, and Galambos, 1974). Each of the seven peaks in ABR has an expected absolute latency. In ABR we may look at interwave latency which is the difference in time between two waves in the same response. The interwave latencies of I-III, III-V, and I-V are often looked at clinically. The value of the I-III latency estimates the time it takes the impulse to travel from the VIIIth nerve through the ponto-medullary junction and lower pons. The value of the III-V estimates the impulse time needed from caudal pons to caudal midbrain levels. The value of I-V estimates the time it takes the impulse to be transmitted through the entire system. Normal average interpeak latencies are: I-III: 2.0 ms. ; III-V 1.9 ms. ; and I-V: 4.0 ms. These estimates are valuable tools for clinical purposes (Fria, 1980).

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When measured in terms of ABR, amplitude is defined as the height of a wave from the peak to the trough following it, measured in microvolts. Starr and Achor (1975) observed variability of amplitude measurements and suggested measuring the relative amplitudes of waves V and I. In a study done with 50 normal subjects, they found that the V/I amplitude ratio in response to click intensities of below 65 dB always exceeded 1.0mv. Chiappa et al. (1979) observed similar ratios. The latencies and the amplitudes of the waves are the two key parameters used in diagnosis.

Evidence exists that the ABR response can be affected by various stimulus factors (Stockard, Stockard, Westmoreland, and Corfits, 1979 ; Bergholtz, 1981). Among the stimulus parameters affecting normal ABR are intensity, repetition rate, polarity, and monaural vs. binaural presentation.

An increase in stimulus repetition rate generally brings about an increase in absolute latency of all ABR waves. Wave V was found to have greater latency increases than wave I when stimulus repetition rate increased (Chiappa, Gladstone, and Young, 1979). The effect of stimulus polarity brought about varying opinions in the literature. Some researchers observed no difference when comparing latency values for condensation and rarefaction clicks (Rosenhamer, Lindstrom, and Lundborg (1978), while Coats and Martin (1977) have found individual variation within groups. Since the spectral energy of a click signal is not frequency specific, tone 'pips' have also been used to elicit responses. Tone 'pips' are short duration tones and have longer rise times than clicks. Mode of presentation (monaural vs. binaural) is another characteristic that has been shown to have an effect on the ABR. When neurologically normal subjects with equal hearing in both ears are stimulated binaurally, there is an increase in amplitude of the component waves (Starr and Achor, 1975).

A major parameter that has a significant effect on ABR is stimulus intensity. A decrease in the intensity causes the latency of the waves to increase and their amplitudes to decrease. In the normal individual, all of these waves are affected about equally in terms of the latency increase. Wave V is sometimes visible down to five or ten dBSL (above behavioral threshold) and is almost always visible within 30 dBSL around 3000 Hz. Waves II, III and IV rapidly decrease in amplitude and may not be visible at these low levels (Galambos and Hecox, 1978).

Differences in the procedure and technique of recording ABR data can influence the results. For example, differences in reference and active electrode placement location can effect the response (Fria, 1980). Also affecting the results are the researchers choice of response reference points. In most studies, a point for latency was chosen at the beginning of the negative slope of the wave. For amplitudes, some researchers compute from the peak to the baseline. Type of earphones used also influences ABR results (Fria, 1980). Earphones have individual resonant characteristics and can cause differing results.

Subject parameters such as age and gender have been found to effect the ABR. The effects of aging on the ABR have been studied by Otto and McCandless (1982). Their subjects consisted of 30 elderly and 30 young subjects, both groups with comparable sensorineural hearing losses. In addition, there were 30 subjects who had normal hearing. They found that subjects who were both older and had a sensorineural hearing loss showed greater deterioration of the ABR waveforms than the young subjects with a sensorineural hearing loss. They also found that there was no pattern of latency lengthening due to aging when comparing interpeak latencies.

Rowe (1978) looked at ABR results with old adults (mean age 61 years) and young adults (mean age 25 years). Contrary to Otto and McCandless, he found that with increased age, there was an increase in the interwave latency I-III (about .2 msecs). Jerger and Hall (1980) conducted a study on age and ABR and found slight effects on the ABR. In their normal hearing subjects, over the range of 25 to 55 years, latency increased about .2 msecs. Amplitudes decreased over this age range by about .050 MV. In sum, older patients have demonstrated wave V latencies which are slightly delayed and amplitudes which are smaller in comparison to younger subjects. McClelland and McCrea (1979) studied pre-adolescent children who had normal hearing sensitivity. In comparison to the adults, both male and female child groups showed no major difference in response latency. It was noted, however, that the latency distribution in the child group was very similar to the adult female latency distribution.

In the development of normative data, gender differences have been overlooked in the past. However, Stockard et al. (1979) point out why it is so important to take gender into account for clinical purposes with differences in the interpeak latencies of .1 to .2 msecs. The differences thought to be associated with age or neurologic disease may actually be accounted for in terms of gender. Jerger et al. (1980) also studied gender differences and its effect on ABR and found pronounced effects. They noted that in normal hearing subjects, females at all age levels showed larger amplitudes and shorter latencies than their male counterparts.

Another study on gender differences in the ABR was conducted by McClelland and McCrea (1979), as mentioned previously. Thirty-nine adult subjects ranging in age from 14 to 34 participated. Twenty one females and eighteen males participated. All subjects were tested using standard audiometric procedures and all had normal hearing. Results revealed that, for wave I, males and females showed no significant differences in latency. Wave III showed a small gender difference. There were slightly longer latencies for males at most stimulus intensities. Clear gender differences were seen in wave V at all intensities. Large gender differences in interpeak latencies of wave I to wave V were found and McClelland and McCrea attributed it to the conduction time differences between male and female in the Central Auditory Pathway. When each gender group was looked at individually, intersubject variability was reduced by about 40%.

Stockard et al.(1979) researched normal variations in the ABR as a function of stimulus and subject characteristics. Gender differences showed that men had longer interpeak latencies than women. Infant interpeak latencies showed no gender dependency. These results suggest that perhaps these gender differences were in fact related to head/brainstem size or to such related factors as external auditory canal length or the diameter of the auditory nerve. A study performed by Weber, Folsom, and Barnard (in press), looked at possible gender differences in the neurological development in pre-term infants. They found significant differences in male-female latencies of wave V ($p<.05$). Another study by Cox, Hack, and Metz (1979) on very low birth weight infants showed significant interpeak latency gender differences favoring females. By four months of age, there were no significant differences between male/female interpeak latencies.

The relationship between head size and evoked potentials has been investigated in areas other than the ABR. Nunez, Reid, and Bickford (1977) performed a study on the relationship of Head Size to the Alpha Frequency of the Electroencephalogram (EEG). These Alpha Frequency oscillations are partly composed of traveling waves. One hundred and fifty nine subjects were used and were put into two groups--those with very large heads and those with very small heads. The results revealed that Alpha Frequency is significantly negatively correlated with head size. ($p=.02$). That is, the larger heads tended to produce slower Alpha Rhythms. Nunez et al. (1977) suggest that analogies between waves in physical systems and brain waves connote that EEG frequency may be determined partly by the surface area of the cortex.

Jerger et al. (1980) felt that further investigation should be done to determine the real basis for the obvious gender differences. Stockard et al. (1979) felt that their results suggested a theory of head/brainstem size. However, at this time ,the relationship between head size and the ABR has not been investigated. Information about this relationship may improve the accuracy of differential diagnosis made from the ABR. Both Jerger et al. (1980) and Stockard et al. (1979) suggest that the female Central Nervous System (CNS), because of its smaller average dimensions, causes the ABR neural transmission time to be reduced in comparison to male data. If smaller CNS dimensions cause reduced neural transmission time and therefore shorter latencies in ABR, actual head size may prove to be an important related factor.

It is our hypothesis that due to the larger dimensions of the CNS, the larger the head size, the longer the latency of the ABR and the transmission time. The purpose of this study was to look at subjects of both genders with various head sizes within each gender, to examine the effect of head size on the ABR latency.

Method

Subjects

Ten male and 12 female adults in the age range of 18-35 years (Mean age = 25) and who had varying head sizes served as subjects in this experiment. One ear was randomly selected and tested per subject. Only subjects who had hearing at 25dB HL or better in the test ear at all test frequencies (250Hz, 500Hz, 1000Hz, 4000Hz, and 8000Hz) were considered for participation.

Apparatus

The study was conducted at the Queens College Speech and Hearing Center. A Grason Stadler model 10 audiometer and TDH 59 headphones were used to obtain a behavioral audiogram for each subject. The Cadwell 5200 Brainstem Response unit was used for averaging and recording of the data. TDH 39 earphones mounted in aural domes were used to deliver auditory test stimuli. Tinplated electrodes were applied to four different sites on the head and the evoked potentials ipsilateral to the stimulated ear were recorded.

Procedure

Each subject was first tested behaviorally in a sound treated room to insure eligibility in this study. The subject was informed about the ABR procedure. Head size was determined by combining three measures: (a) circumference, (b) tragus to tragus over the top of the head, and (c) inion to nasion to form a measure of overall head size. Nylon monofilament (fishing line) was used to obtain head measurements in order to rule out effects of hair thickness. The nylon line was then measured on a centimeter tape measure and head sizes were recorded.

Tinplated electrodes were placed on four locations on the head: the vertex (reference), the center of the forehead (ground), and one on each mastoid (active). After being plugged into the Cadwell amplifier, the electrodes were checked for proper impedence. If peak to trough of the random waves were larger than one microvolt, the electrodes were rechecked for accurate placement and contact.

The subject's click threshold was obtained in the test ear and then he was told to lie on the cot and be as relaxed as possible. The subject was told that no behavioral response was necessary and to try not to be tense or make too many movements. The intensity of the click was raised to 70 dB SL in the test ear. This was the first intensity used in this experiment. A repetition rate of 11 clicks per second was used with a total number of clicks per run equalling 2048. Two runs of every intensity observed were recorded to insure reliable and repeatable results. The amplitude of wave V and latencies of waves I, III, and V were then measured. Amplitude and latency measurements were determined by two judges to improve reliability. This procedure was repeated at two more intensities: 50dB SL and 30dB SL. The entire experiment took approximately one and one half hours for each subject.

Results

Table 1. Absolute latency values for waves I and V and the I-V interpeak interval.*

	Wave I	Wave V	I-V Interval
Average for all subjects in this study	1.84ms	5.91ms	4.07ms
Normative values (Coates, 1979)	2.03ms +/-.22	6.00ms +/-.39	3.97 +/-.36

* An intensity of 70dB SL was used in this study and 68dB SL was used in the Coates study.

Table 1 shows the average latency values for wave I, wave V, and the interpeak interval of waves I-V, for all subjects who participated in this study. Also shown in this table are normative data for waves I, V, and the interpeak interval of I-V, as stated by Coates (1979). The average latency value data for this study and the normative data by Coates are close in latency values and all of the wave latencies from this study come within the standard deviation of the Coates normative values.

Table 2. Latency values according to gender*

	Wave I	Wave V	I-V Interval
Average female latencies (in this study)	1.77ms	5.73ms	3.95ms
Normative latency values for females (McClelland & McCrea (1979)	-	5.65ms +/-.03	3.92ms +/-.03
Average male latencies (in this study)	1.93ms	6.13ms	4.20ms
Normative latency values for males (McClelland & McCrea 1979)	-	5.95ms +/-.03	4.19ms +/-.04

* The average female and male latency values for this study are being compared to normative male and female latency values from McClelland and McCrea (1979). The intensity level of this study was 70 dB SL. The intensity level used by McClelland and McCrea was 80dB nHL.

Table 2 reveals latency data according to sex. Various studies (Jerger et al. 1980 ; Stockard et al. 1979) have found gender to be a factor to be considered in looking at the ABR. Average female and average male latency data for waves I, V, and the I-V interval are shown along with normative data from McClelland and McCrea (1979) as broken down into male and female groups. Normative values were given for wave V and the I-V interval. In examining this table, we see that the male and female values for this study are close to the normative data provided by McClelland and McCrea. The I-V intervals fit into the norms when adding the standard deviation provided. However, in both groups, the wave V latency values are greater than the norms provided by McClelland and McCrea with the standard deviations added.

Table 3 shows that the absolute latencies of wave V tend to increase as overall head size increases. From this we can infer that the larger the head size, the greater the wave V latency, and the greater the I-V interpeak interval.

Table 3. Latency data and interpeak intervals at 70 dBSL.*

Subject	Head Size	Wave I	Wave V	I-V Interval
1	123.5	1.70	5.52	3.82
2	125	1.66	5.75	4.09
3	126.5	1.66	5.55	3.78
4	127	1.89	5.39	3.50
5	127.5	1.74	5.46	3.72
6	128.5	1.89	5.86	3.97
7	129	1.74	5.73	3.99
8	129	1.95	6.09	4.14
9	129.5	1.66	5.73	4.07
10	131	2.05	6.09	4.04
11	132	1.76	5.73	3.97
12	133.5	1.53	5.83	4.30
13	127.5	2.22	6.04	3.82
14	128.5	1.80	5.96	4.16
15	128.5	1.93	6.15	4.22
16	129	1.86	5.79	3.93
17	130	1.82	5.88	4.06
18	133	1.80	5.81	4.01
19	133.5	2.15	6.46	4.31
20	141.5	1.74	6.15	4.41
21	143	1.93	6.55	4.62
22	154	2.03	6.53	4.50

* Subjects #1 - #12 are females listed according to overall head size in cm. starting with the smallest head and ending with the largest head. Subjects #13 - #22 are males listed according to overall head size starting with the smallest head and ending with the largest head.

A regression procedure was used to test the relationship between head size and wave V latencies and the interpeak interval I-V. The results of this procedure revealed a coefficient correlation of .72 for wave V latency and head size, and a coefficient correlation of .71 for the I-V interpeak interval and head size. These coefficients were shown to be significant at the .0001 level.

Discussion

The purpose of this study was to investigate the clinical use of measuring head size and evaluating its importance in using ABR to make differential diagnosis. Male subjects with the smallest heads and the female subjects with the largest heads show latencies which are in agreement with published norms for the opposite gender. For example, subject No. 16, a male with one of the smallest head sizes within the male group, fits in well with the female normative latency values. If his latency data was compared to normative data based on male gender, he would be found to have shorter latencies than were considered to be within normal limits for males.

If subject No. 12, the female with the largest head within the female group, was compared to the female normative data she would be thought to have abnormal ABR latencies. Her latencies are longer than the normative data allows for females. However, if you compare her with the male latency data norms, she compares rather well. Subjects Nos. 20, 21, and 22 were male subjects with the largest heads. Both the wave V latency and I-V interval are much greater than the latency values by McClelland and McCrea. This would lead ABR clinicians to believe that an abnormality exists within the brainstem, when in fact, it could be related to head size. The chances that all these men have retrocochlear abnormalities are very slight.

Subject No. 1 has wave V and I-V interval latencies which are smaller than the stated norms. When compared to the female norms, she had shorter latencies that could be considered abnormal. However, her data can be logically explained by her relatively small head size. The I-V interpeak interval of subjects No. 12 (female) and subject No. 19 (male) are very close: (4.30ms.; 4.31ms). They also have the same overall head size (133.5).

According to McClelland et al. (1979), pre-adolescent children with normal hearing sensitivity show no major difference between male and female, however,they were similar to the adult female latency group. This suggests that children, who generally have smaller heads than adults, are closer to female latency data. In this study, females have average head sizes (Mean = 128.5 cm.) that are smaller than the average male head sizes (Mean = 135 cm.).

It is also possible to misdiagnose an individual with a small head size. If you compare a client's latency results with average published norms, the latencies may fall within the normal range data, even if the latencies are much longer than expected in relation to head size. Therefore, the audiologist could miss an abnormal ABR and diagnose the results as normal. This reveals the danger of using "standardized"

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latency normative data in clinical interpretation when a subject variable such as head size has not been considered. The results support the hypothesis that head size is a factor to be taken into consideration when comparing results to the normative data. It is also suggested that this factor be examined again on a larger scale where results similar to this study would further confirm the effect of head size on the Auditory Brainstem Response.

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The Effect of Context on Preschool Children's Understanding of Synthetic Speech - A Pilot Study

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Abstract

The purpose of this study was: (1) to devise a comprehension task within a naturalistic context that could test the ability of preschool children to understand synthetic speech; and (2) to use that task to examine the effect of context on preschool children's ability to understand synthetic speech messages. Two normal preschool children served as subjects for the study. Results suggested that the contextual support included in the sentence comprehension task facilitated the subjects' understanding of the synthetic speech message. Implications for further study are discussed.

Technological developments have provided a wide array of aids and devices which can be used to supplement the communication skills of persons with severe speech and physical handicaps (Kraat and Sitver-Kogut, 1985). Recently, advances in synthetic speech have been rapidly integrated into these augmentative communication devices to provide voice output for the users of this technology. Commercially available communication devices now contain a variety of speech synthesizers (e.g, systems based on the Votrax SC-01 chip, Votrax Personal Speech System, Echo II and internal chips, and SSI) and methods by which speech output is generated and input (Goodrich, 1979; Elovitz, Johnson, McHugh, and Shore, 1976; Hertz, 1981, Damper, 1982; Klatt, 1982; May, 1982; Bell, 1983).

Although there has been great interest in the development and use of speech synthesis, very little research has been conducted with regard to the intelligibility, converstional use, and effectiveness of that synthetic speech. These are important areas of concern as these synthetic speech modes often serve as the primary communication mode between nonspeakers (preschoolers, children and adults) and their communication partners.

The few research studies that have examined the intelligibility of synthetic speech currently used in augmentative communication devices have indicated that these systems are often of reduced quality and poor intelligibility in comparison to natural speech (Chail, 1976, 1984; Neilsen, 1979; Williams, Simpson, and Nordinger, 1981; Kraat and Levinson, 1984; Levinson and Kraat, 1984; Wieck, 1984). These studies report intelligibility scores of between 10-60% for single word intelligibility tests, and 25-70% for sentence intelligibility tests. The variation in these results reflects differences in the synthesizer or device studied, the intelligibility test used, and variations in statistical analysis. Studies in synthesis intelligibility have further indicated that noise levels have a particularly detrimental effect on synthesis intelligibility (Chail, 1976, 1984; Nielson, 1979; Pisoni and Koen, 1982, Clark, 1983). The work of Nye and Gaitenby (1974), Pisoni (1981), and Nusbaum and Schwab (1983) also suggests that increased exposure to synthetic speech may improve the overall intelligibility of that speech mode to a listener.

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Research examining the intelligibility of synthetic speech has generally used normal adult subjects. It is presently unclear whether synthetic speech is as intelligible to preschoolers, young children and persons with reduced language abilities. It is often the case, however, that persons using augmentative communication devices with speech output capabilities are communicating with young children or other disabled persons. Weick (1984) studied the ability of twenty-four preschool children to identify synthetic word stimuli produced by the VOIS 130 communication device and natural speech using the Word Intelligibility Picture Identification (WIPI). Although scores were poor using the VOIS 130 (e.g, children correctly identified only aobut 50% of the synthetic words), this research has not been duplicated over a broad age range.

There is a need to examine the perception and comprehension of fluent synthetic speech as well as phoneme/word intelligibility. This information is crucial to our understanding of conversational interaction between users of communication devices with synthetic speech and others. The complex relationship between word/sentence intelligibility tests and the actual comprehension of spoken language in a conversational context is not well understood. However, it is generally felt that the understanding of language is superior when spoken language occurs in a natural communication situation. The acoustic-linguistic signal is only one of the several sources of information available for the interpretation of messages. In everyday conversations, multiple linguistic and extra-linguistic cues are present to assist the listener in understanding a clear or distorted message.

The multiple cues provided in comprehension of a sentence or on-going conversational speech are generally referred to as 'context'. Context is viewed as the complex interplay of a variety of linguistic and nonlinguistic information that is on-going and dynamic, and which serves as a framework within which understanding takes place (Chapman, 1978; Cook-Gumperz and Gumperz, 1978; Prutting, 1982). Researchers vary with regard to the dimensions of context that they consider, and how they view the listener's use of this information in processing spoken language. Collectively however, several dimensions of 'context' have been suggested as important contributors to our understanding of a spoken message. These include, among others: 1) the phonological, semantic and syntactic rules of language; (2) the probability of a particular semantic relation or form occurring in a given situation; (3) the expectancies established by the content and form of utterances previously spoken; (4) the on-going topic of conversation; (5) paralinguistic and nonverbal behaviors accompanying an utterance; (6) the physical objects and actions in the immediate environment; (7) knowledge and familiarity about objects, people, and actions, and how they usually interact; and, (8) knowledge about a particular communiction situation and partner based on previous experiences with

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them; (Miller, Heise and Lichten, 1951; Giolas and Epstein, 1963; Giolas, 1965; Bransford and Johnson, 1973; Ervin-Tripp, 1973; Duffy and Giolas, 1974; Huttenlocher, 1974; Strohner and Nelson, 1974; Argyle, 1975; Bloom and Lahey, 1978; Bransford and Nitsch, 1978; Cook-Gumperz and Gumperz, 1978; Rees, 1978; Shatz, 1978; Lund and Duchan, 1983; McGarr, 1983). These expectancies, redundancies, and cues appear to assist in the comprehension of speech and the intention associated with an utterance or utterances. It is probable that they become of greater importance to spoken language comprehension when a content of a message is unclear, or the acoustic parameters of the message are distorted or disintegrated (e.g., a hearing loss, comprehending speech in a noisy situation, understanding a foreign or dysarthric speaker, etc.).

Researchers studying language development in preschool age children have observed that even young children use contextual cues and probabilities in early comprehension strategies. In a sentence comprehension study involving 2.0 to 4.0 year old children, Strohner and Nelson (1974) concluded that sentences were better comprehended if the events described were probable in the child's world. They also found that the children in their study did not guess randomly, but relied on information supplied by the nonverbal contexts that accompanied a sentence to predict the probable meaning. Shatz (1978) also noted that young children used contextual information to interpret communicative interactions. She examined the comprehension strategies of 18 children between the ages of 19-43 months in their response to two experimental conditions. In one condition, a variety of sentence types which could be interpreted as directives or information seeking were presented in a play context in a neutral manner. In the second condition, the same sentences were presented following a series of setting sentences which either supported action or informing responses (e.g., a series of imperatives; a series of sentences referring to object properties). Results indicated that the setting sentences influenced the young children's response to the test sentences that followed. Shatz concluded that even very young children can engage in a context sensitive process of interpretation.

Of interest in augmentative communication use is the extent to which multiple contextual supports that occur in natural conversation affect the listener's ability to comprehend language spoken through a synthetic speech device of reduced intelligibility. To date there has been minimal research attention to the comprehension of synthetic speech.

David Pisoni and his colleagues at the Speech Research Laboratory at Indiana University have begun to study the processing and comprehension of synthetic speech by naive adult listeners. The synthesis under study is that produced by the MITalk, one of the most intelligible of the synthetic speech systems, and one rarely used in augmentative communication devices because of price, availability, and portability. Pisoni (1981) presented 15 narrative passages and multiple choice test questions to twenty adults using speech syntehsis, and the same passages and test questions to two groups of twenty adults in natural speech and written form. Performance for the group presented with written material was superior. In the second half of the test, however, those listening to synthetic speech achieved performance levels approaching the reading

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group. Natural speech presentation remained slightly lower. This test was duplicated by Luce (1982) with different test questions. The questions were designed to test surface structure informtion and more abstract, inference information. Luce found performance on the MITalk to be poorer for comprehension questions designed to probe the content of a given passage in contrast to retention of the surface structure of the passages.

Luxton (1983) investigated the ability of sighted and normal seeing adults to comprehend paragraphs from the Sequential Test of Educational Progress (STEP) spoken by the synthesizer in the Kurzweil Reading machine and in natural speech. Her findings were in contrast to Pisoni et al. Comprehension of the content of the paragraphs was poorer for the synthesized speech condition, and particularly poor for adults with lower verbal ability scores. The differences may be attributed to the different synthesizer, comprehension passages, or the type of questions asked. Luxton indicatec that many listeners reported difficulty understanding the speech signals and simultaneously comprehending the spoken material.

Pisoni et al. have also investigated the processing of synthetic speech signals through studies involving lexical decision (Pisoni, 1981) and word recall tasks (Luce, Feustal, Pisoni, 1981). This work suggests that some of the difficulties in processing synthetic speech may arise from more general constraints on the processing of information in short term memory. As cognitive requirments increase and multiple processing is required, the listener may be less able to comprehend synthetic speech adequately.

To date, there are no known studies of the understandability of speech synthesis in conversation, or comprehension studies involving the synthetic speech devices actually used by nonspeaking children and adults. This pilot stucy represents a beginning exploration of the extent to which contextual supports might influence comprehension of utterances produced through an augmentative communication device. Specifically, this study addresses the following questions:

1) Does context have an effect on preschool children's ability to understand synthetic speech produced by a VOIS 130 communication device? If so, in what way?

2) Does context effect the comprehension of synthetically spoken directives of increasing length and syntactic /semantic complexity in a similiar manner?

Method

Subjects

The subjects JD and JW were normal presschoolers, age 4.0 and 4.10. Language comprehension abilities for these children as assessed by the Test for Auditory Comprehension of Language (Carrow,1973) were slightly above chronological age. JD , the younger child, received a score or 5.11, and JW scored at 5.3. Both children were unfamiliar with synthesized speech and served as naive subjects. Prior to the experimenal tasks, each child was given a prescreening to ensure that

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they had hearing within normal limits bilaterally. A color identificatin task was also administered to assure tht the subjects could make the color distinctions used in the experimental tasks.

Apparatus/Materials

Two experimental tasks were constructed. These included a sentence comprehension task (Experimental Task I) administered within a structured play activity to examine comprehension within a naturalistic context, and a single word intelligibility task (Experimental Task II) to provide a measure of speech intelligibility outside of a context. Both tasks were presented under two stimulus conditions, taped natural speech and synthetic speech.

Experimental Task I- Sentence Comprehension:Thirty-two (32) stimulus sentences were developed for the experimental task (See Appendix A). All were directives in the imperative form. Directives were selected because they could elicit an observeable action response from the child, and they are a part of the child's language repertoire at an early age (Gelman and Shatz, 1977; Shatz, 1978).

The stimulus sentences consisted of four (4) basic sentence types differing in semantic/syntactic content and length (See Table 1). Each sentence type was represented by eight (8) stimulus sentences. The sentences were created to be plausible directives that might occur in a play activity centered around a Lego Universal Building Set (#355). The play context developed to accompany the sentence presentations consisted of helping to construct an airplane, a horse and a park from the Lego parts, and acting on objects involved in the activities. (See Appendix B for the play script).

Table 1. Characteristics of the different sentence types.

Sentence Type	Length (# of words)	Semantic Form	# of Key Elements
I	3-4	Action-Object (Get the wheels)	1
II	6-7	Action-Object-Location (Put the boy on the horse)	2
III	9	Action-Object + Action-Object-Location (Get the flag and put it on the plane)	2
IV	13-14	Action-Object-Location + Action-Object-Location (Take the flag off the plane and put it on the horse)	2-4

The physical context present during each stimulus sentence presentation was pre-established. The physical context consisted of five objects, either Lego pieces, prebuilt objects, or toy people and animals. The five items in the response context were selected so that the child could not easily guess the appropriate action without comprehending at least certain key elements in the stimulus sentence. For example, the stimulus sentence "Get a blue piece" was presented while five Lego pieces were in view, a red, blue, yellow, white, and black piece. In this situation, the word "blue" needs to be comprehended to complete the directive corectly.

Each sentence type was controlled for sentence - context predictability by the object foils in view at the time of the sentence presentation. Type I sentences required a single word to be comprehended to perform the appropriate action; Types II and III required two words to be understood; Type IV had three sentences that required two words for minimal comprehension, and five sentences that required four key elements to be understood for comprehension. The foils for each stimulus sentence and the key elements that need to be understood in each sentence presentation are outlined in Appendix B.

In addition to the response foils, the comprehension task included other contextual support across sentence presentations. These included: 1) the predictability within play themes (e.g., building a horse; playing with the horse); 2) the expectancies established for a directive; 3) the predictability created from previous directives in the task; 4) knowledge about how the available objects can and usually do interact in a construction or play activity; and, 5) the predictability supplied by the semantic/ syntactic structure of a sentence.

The thirty-two (32) stimulus sentences were randomly assigned to a synthetic speech or natural speech condition within sentence types. For sentence type I, II, and III, four sentences were assigned to synthetic speech and four to natural speech. For sentence type IV, where the number of key elements needed for minimal comprehension varied, five sentences were assigned to synthesis and three to natural speech to balance the number of key elements in both conditions.

The stimulus sentences were recorded on a Uher 4200 tape recorder at a speed of 7 1/2 IPS with a Sennheiser MD 441 microphone. The order of sentence presentation followed the script dictated by the play task (See Appendix B). The synthetic speech was supplied by the VOIS 130 communication device, manufactured by Phonic Ear, Inc. This device uses a Votrax based chip. Sentences on the VOIS 130 were created using available phonemes. The natural speech was supplied by a native male speaker who used a natural prosody that complied with the syntactic form of the sentence, but contained no additional item stressing or pauses. The male speaker attempted to perceptually match the pitch and rate of the synthetic speech produced by the VOIS 130. Natural and synthetic sentences were equated for intensity in that the intensity level on the VU meter of the tape recorder peaked between 7-10 for each presentation.

Experimental Task II - Word Intelligibility: All of the words occurring in the thirty -two experimental sentences served as the stimulus for the intelligibility task. The thirty (30) single words consisted of 16 nouns and modifiers, and 14 verbs, articles and prepositions. Half of each grouping (e.g, 8 of the nouns and modifiers) were assigned to the synthetic speech condition and half to the natural speech condition (See Appendix C). The single words were randomized with regard to order and mode of presentation.

The stimulus words were recorded on a Uher 4200 tape recorder at a speed of 7 1/2 IPS with a Sennheiser MD 441 microphone. They were equated for intensity in that each word peaked at between 7-10 on the VU meter of the tape recorder. The natural speech was supplied by the same native male speaker as in the sentences presentations. Again, the natural speaker attempted to perceptually match the pitch and rate of the synthetic speech. The synthetically spoken words were generated by the VOIS 130 device using available phonemes.

Procedure

Experimental Task I: All testing was done in a sound-treated room at the Queens College Speech and Hearing Center. The child was seated to the left of the examiner who was familiar with the child. A Radio Shack robot (TC) was positioned to the right of the examiner and used as the source of the pre-recorded stimulus sentences through the activation of a tape recorder. The session was video-taped using a Sony Betamax (SL340), and performance recorded on-line by a second examiner.

To acquaint the subject with the task, four pre-test sentences were presented by TC through the tape recorder. These included two sentences in natural speech and two synthetic sentences from the VOIS 130. All were yes/no or product questions (e.g., do you watch TV?; What is your name?). If the child did not understand, the examiner repeated the presentation with cues (e.g.,I think its about TV).

The Lego set was then presented and the child told "TC the robot is going to help us build some things. We have to wait for him to tell us what to do. Listen very closely and don't do anything until TC tells us to do it."

The examiner followed a play script (See Appendix B) that required the subject to build a horse, then an airplane, and play with these objects. The stimulus sentences were interspersed within this script. Filler sentences and actions made up the remainder of the script and served to move the task along and keep the subject's attention. These fillers commented on the features of the Lego toys and the performance of the child but offered no clues to the next action requested in the stimulus sentences. Immediately before the presentation of a stimulus sentence, the examiner told the subject: "TC is ready to tell us something. Let's listen closely." This served to quiet the child and make sure he was attending.

Prior to each stimulus sentence, a new set of "foils" was placed on the table and others removed. These "foils" were placed in a straight row when the action involved adding one of the foils to an object in front of the child, (e.g., get the boy; put the boy on the horse); and in a circle when objects within the context were to act on each other (e.g., Take the boy off the horse and put the flag on the plane).

If the child did not respond to a stimulus sentence, the examiner prompted him to make a guess and then waited. If there was still no response, or there was an incorrect response, the examiner manipulated the objects in play to be ready for the next stimulus sentence presentation. No sentence repetition was provided.

The children were presented with part of the stimulus items (20 sentences) and then given a play and snack break. The experimental session took approximately 30-45 minutes.

Responses were recorded during the experimental session by the second examiner. Responses were recorded as correct or incorrect at the sentence level. Three types of errors were noted as incorrect reponses: 1) no response (no action taken); 2) incorrect response (incorrect action taken); 3) partial response (partially correct action taken). The examiner's on-line recording was checked for reliability against the video-tape by the first examiner. Differences were resolved by the agreement of both examiners.

Experimental Task II: Three weeks later, the subjects were given a word identification task. Single words were presented to the subject via a tape recorder. The subjects were instructed to repeat the word heard. If the child did not respond to a stimulus word, the examiner prompted him to make a guess and waited. If there was still no response, the examiner went on to the next word. No word repetition was provided. The experimental session took approximately 10 minutes.

Responses were recorded by the examiner during the experimental session. Responses were recorded as correct or incorrect. Two types of errors were noted as incorrect responses: 1) no response; 2) incorrect responses or substitutions.

Results

Both subjects made no errors in the sentence comprehension task or the word intelligibility task when presentation was in natural speech. In contrast, both subjects made errors in both tasks when presentation was in synthetic speech. The subjects' performance was superior in the sentence comprehension task over the word intelligibility task suggesting that the contextual support included in the sentence comprehension task facilitated the subjects' understanding of synthetic speech.

Although both subjects showed the same contextual effect for the synthesized speech condition, the degree to which context appeared to facilitate understanding differed across subjects. (See Table 2).

Table 2. Percentage of correct responses in synthetic and natural conditions.

Subjects	Synthetic Words (15)	 Sentences (17)	Natural Words (15)	 Sentences (17)
JD	46.7	70.6	100.	100.
JW	26.7	82.4	100.	100.

Subject JW demonstrated a much larger effect for context as evident from the difference between his scores on the single word intelligibility task and the comprehension of directives presented in the play context . JW 's performance on the intelligibility task was 26.7% as opposed to 82.4% for the sentence task. JD's performance was 46.7% and 70.6% respectively.

The subjects also varied with regard to the sentences that were difficult. As Table 3 shows, JD made more errors on sentence type III and IV sentences when presented in synthesized speech. These sentences were longer and more complex than type I and II sentences. JW's performance was more consistent across sentence types with a 100% score for the longest and most complex sentence group. From this pilot study, it is therefore difficult to draw any conclusions about the relationship of synthetic speech, the length and complexity of directives, and contextual support.

Table 3. Percentage of correct responses in the synthetic sentence comprehension task.

Sentence Type	JD	JW
I	75 %	75 %
II	75	75
III	50	75
IV	60	100

Neither subject made any guesses when prompted to do so following a 'no response'. In analyzing the errors of the two subjects on the sentence comprehension task, similarities and differences were evident. Of the eight (8) sentences missed by the subjects, only two were common to both subjects: sentence 1 - Get the blue piece, and sentence 14 - get the flag and put it on the plane. JW made no response to two sentences (#1 and 14), and got sentence #29 partially correct, substituting girl for boy. JD made no response to one sentence (#1), made subject substitutions for sentences #14 and 24 (i.e., flag/tree; boy/flag), made no response to the second half of sentence #8, and substituted the subject for sentence 14 (i.e. boy/flag), followed by a no reponse.

In the word intelligibility task, both subjects made about an equal number of errors across form class groups (i.e., nouns/modifiers; verbs/article/preposition) for the synthetic speech condition. Although JD had a larger percentage of words correctly identified, the two subjects showed much more commonality in their errors than for the sentence comprehension task. All of the words missed by JD (8/15) were also missed by JW (11/15). The common words missed in the intelligibility task were: blue, yellow, girl, tree, off, of, him, her. Errors were both no responses and substitutions. JD gave five no resonses, and three substitutions. JW gave six no responses and five substitutions on the task. In both subjects, some of the substitutions were closely related phonemically to the stiumulus (e.g., three/tree; bread/red) and others were more distant (e.g., can/her; key/him). Neither subject made any attempt to guess when they were prompted to do so following a no response.

Discussion

While this is a limited pilot study, the results indicate that context does facilitate preschool children's understanding of synthetic speech and warrants further investigation. These preliminary results also lend further support to the language acquisition literature which suggests that preschool children do not rely on the linguistic message alone to understand spoken language, but draw instead on a multitude of cues from the context of the ongoing speech event (Bloom and Lahey, 1978). When faced with a distorted or unclear linguistic message, children look to clues present in the physical, situational and conversational contexts to help them decipher the messge (Strohner and Nelson, 1974; Constable, 1983; Lund and Duchan, 1983).

The multiple contextual cues available in the sentence comprehension task considerably increased understanding over the single word intelligibility task. The contextual support did not, however, bring the children's comprehension scores up to the level of single words or sentences presented in natural speech. The use of contextual cues and probabilities were evident, however, throughout the sentence comprehension task, and particularly during synthetic speech presentations. Given the less intelligible speech signals, these children continued to 'put', 'give', and 'take' available objects, and never deviated from this behavior. The substituted errors also reflected the use of what is probable given the available context and a distorted signal. The object substitutions bore little relationship to the acoustic signal presented, but were highly probable given the play context and part of the signal (e.g., JW's substitution of flag for tree in the directive, "take a tree and put it on the hill" when the foils tree, dog, horse, plane, and boy were present and taking the flag had been a previous directive in natural speech). It was also noted that JW frequently gave part of a response, hesitated, and then completed the action appropriately. JW also overtly verbalized his expectancies at one point saying, "Is he (TC) going to say to do this again?" referring to taking the girl off something and putting the boy on something.

It is difficult to explain why JW showed a much larger increase between the single word task and comprehension of sentences in the structured play context than JD. Three possible explanations are offered. First, this was a pilot study of two children and perhaps these differences reflect the standard deviations for a larger group of preschool children on the same task. Second, it also may be that processing strategies for synthetic speech differ across individuals. JW may rely more heavily on language and contextual cues in processing, and this is reflected in his poor single word score and high sentence comprehension score. JD on the other hand, may have been using the acoustic signals to a greater extent to process information. This might explain his higher single word score, and his comparatively lower score on the sentence comprehension task. Third, it also was the case that JW, the older of the two subjects, was a more socially mature child who seemed more attentive and responsive to the experimental session as a whole. He appeared to want to do well, and was actively involved. JD was less sure of himself and what was expected of him, did not attend as well, and was in a hurry to finish. This may have affected his sentence comprehension score as he took less time to assess the contextual clues and integrate them with the linguistic message.

The children performed very differently on the four basic sentence types in the comprehension task. JD's performance suggests that he had more difficulty in comprehending sentences when they were longer and more complex. JW did not. Again, this is difficult to explain. JD is chronologically younger than JW. Perhaps the length and complexity were more taxing to him at his age level, and therefore, his performance was poorer.

Both children seemed to use repetition as a processing strategy in the sentence comprehension task. JW repeated part or all of every correct sentence, whether it was presented in natural taped speech or synthetic speech. These repetitions occurred while he carried out the requested action, and in some instances, was not a correct repetition although he took the correct action. This may indicate that JW uses repetition as a general processing strategy to give himself assurance and time to understand messages. JD did not repeat as often as JW, but did so more with the synthetic signals when he was unsure of the message. For him, repetition seemed to be a processing strategy to fall back on when messages were difficult to understand.

It is interesting to note the requests for clarification that were produced by the two children in the structured play context. In general, few verbal or nonverbal requests for clarification or repetition were noted. JD asked directly two times, "What did he say?" JW commented indirectly a few times ("I don't know what he said"), or reflected difficulty in understanding (e.g., "but where shall we put him") even though he completed the action correctly. Most of the literature on requests for clarification made by preschool children have centered on their responses to semantically uninformative or ambiguous messages (Cosgrove and Patterson, 1977; Ironsmith and Whitehurst, 1978; and Patterson, Cosgrove and O'Brien, 1980) and suggest that children at that age may not ask directly for clarification, and when they do so, may ask general or nonspecific questions (e.g., I don't know which one it is). The performance of these two preschoolers suggests a similiar pattern, although little information is presently known about how young children respond to acoustically distorted vs. semantically ambiguous messages.

The children shared many common errors on the word intelligibility task. This suggests that certain phonemes are more difficult to perceive and understand when presented in synthetic speech and corraborates the work of Neilson (1979) Pisoni (1981), and Clark (1983). The results of this word intelligibiltiy test differ somewhat from the work of Wieck (1984) who also studied synthetic and natural speech intelligibility with children of this chronological age level. Wieck was also the only other researcher to report intelligibility scores for the VOIS 130 communication device. Wieck's naive subjects obtained a mean score of 50% for synthetically spoken words, and 80% for the taped natural speech condition. In this study, both children received a 100% score in the natural speech condition. JD's word intelligibility score (46.7%) more closely approximated the Wieck data than did JW's (26.7%). The differences for taped natural speech are difficult to explain, especially since Wieck's procedure used a forced choice paradigm and this study used one of free choice, which is considered more difficult. One might suggest that the children remembered the lexical items three weeks after the structured play task. This, however, does not seem to be substantiated by looking at the errors the children made. For example, 'girl' and 'tree' were errors in our word identification task, and were salient characters in the play script.

The findings in this pilot study warrant further investigation with a larger group of preschool children. The structured play task developed for this pilot study also appears to be a viable means through which the ability of preschool children to process and comprehend synthetic speech might be further studied. The Lego task held the attention of the children, was sufficiently difficult so that errors were made, and generally proved to be a good tool through which to study young children (3-6 years) as 'listeners'.

Several other studies of the intelligibility and comprehension of synthesized speech with children are of interest and need to be done. During the course of this study, several of these have been suggested. Both subjects were unfamiliar with synthetic speech. Research has indicated that increased exposure to synthesized speech can result in improvement in response accuracy (Pisoni, 1981). Studies on the effect of context with subjects familiar with synthetic speech or with repeated exposure needs further study. Studies with different linguistic forms may also prove of interest. The present study found that context aided children's understanding of directives, a form present in early child language; however, it may be that context is not as facilitative with more complex syntactic forms, or that a different set of contextual variables may affect directives differently..

Further studies might also focus on context itself, and the many variables contained within it. For example, future studies might add a sentence identification task to the present study's design thus adding another measure of context. Another area of context not considered in the present study are the cues found in the supra-segmental characteristics of speech, i.e., prosody, stress and intonation. A study of this nature may consider whether these variables may further facilitate or not facilitate understanding of synthetic speech, and to what degree.

Future studies could also be conducted with children at various developmental levels to determine whether understanding of synthetic speech signals improves as a child gets older, learns to read and/or develops more sophisticated language skills. It may also be of interest to evaluate the performance of other synthesizers when contextual clues are present, and compare those results to those obtained for the VOIS 130. Intelligibility tests have indicated that the quality of the voice output between synthesizers varies greatly and further studies may indicate whether context affects these finding differentially.

Certainly, the need for further study in the area of speech synthesis is apparent. The relationship between the intelligibility of our currently used speech output communication devices and the ability of a variety of listeners to understand that communication in everyday cntexts is of primary importance. To begin to examine these devices in structured communication contexts represents an important step toward that understanding.

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Appendix A

Stimulus Sentences By Type

S - synthesis
N - natural

Type 1:

S 1. Get the blue piece
N 2. Get a red piece
N 4. Get a yellow piece
N 6. Get a white piece
S 10. Get a red piece
N 11. Get a yellow piece
S 12. Get the wheels
S 17. Get the horse

Type 2:

N 3. Put the red piece on top
N 7. Put the boy on the horse
N 13. Put the red piece on the wheels
S 19. Put the plane in the box
N 21. Get the horse out of the box
S 25. Take the boy off the horse
S 29. Put the boy on the plane
S 31. Put the flag on the plane

Type 3:

N 5. Take the yellow piece and put it in top
S 14. Get the flag and put it on the plane
N 15. Get the boy and put him on the plane
S 22. Take the boy and put him on the horse
S 24. Take the tree and put it on the hill
N 26. Take the dog and put him on the hill
N 30. Get the dog and put him on the hill
S 32. Get the horse and put him on the hill

Type 4:

S 8. Take the boy off the horse
and put the girl on the horse
N 9. Take the girl off the horse
and put the horse in the box
S 16. Take the boy off the plane
and put the girl on the plane
S 18. Take the girl off the plane
and put the dog on the horse
N 20. Take the dog off the horse
and put the horse in the box
N 23. Take the flag off the plane
and put it on the horse
S 27. Take the boy off the hill
and put the boy on the horse
S 28. Take the girl off the plane
and put the girl on the horse

Note: The numbers for the stimuli sentences correspond to the script

Underline denotes key elements.

Appendix B

Sample Script

Let's build a horse
OK, let's see what we need
First, let's build the legs

1.Foils: Line
Lego pieces - red, white, yellow, black and blue

This will be fun
TC is ready to tell us
something. Let's listen
closely.

1) Get the blue piece

Okay, that was great
TC is ready.......

2) Get a red piece

I think this will look
great. TC is ready.......

3) Put the red piece
on top

Good work. TC is ready...

4) Get a yellow piece

All right, that's terrific
TC is ready........

5) Take the yellow
piece and put it
on top

All right, that's one leg
Now, let's do another one (finish other leg)
Great, now we have two legs

They look good. TC is ready...

6) Get a white piece

Let's put another white piece on the other leg.
Let's finish the horse. What colors do you want to use?
(Finish horse)

2. Foils: Line
2 boys, girl, dog, box

He looks great. TC is ready....

7) Put the boy on
the horse.

I think the boy wants a ride
Give him a ride, too

That was fun. TC is ready...

8) Take the boy off
the horse and put
the girl on the
horse

Now, let's give her a ride

That was great. TC is ready...

9) Take the girl
offthe horse and
put the horse in
the box

Now, let's build something else so we'll have lots of things for them to ride.
How about a plane?

3. Foils: Line
Lego pieces - red, yellow; boy, wheels ,flag

This will be fun. TC is ready...

10) Get a red piece

That's great. TC is ready....

11) Get a yellow piece

It will look great.
TC is ready.......

12) Get the wheels

Terrific! TC is ready....

13) Put the red piece
on the wheels

I think we should finish this plane. (Finish plane)

4. Foils: Circle
Girl, boy, horse, plane, flag

That looks good. TC is ready....

14) Get the flag and
put it on the
plane

5. Foils: Circle
Girl, boy, horse, plane, dog

That really looks great.
TC is ready......

15) Get the boy and
put him on the
plane

6. Foils: Circle
Girl, boy, horse, plane, dog

Let's take him for a ride

That looks like fun.
TC is ready......

16) Take the boy off
the plane and put
the girl on the
plane

That was great. TC is ready....

17) Get the horse

All right, now we have a horse and a plane for them to play with

7. Foils: Circle
Girl, boy, horse plane, dog

This is great. TC is ready....

18) Take the girl
off the plane and
put the dog on
the horse.

8. Foils: Circle
Girl, boy, horse, plane, box

All right, that was good.
TC is ready.....

19) Put the plane in
the box

Good work. TC is ready.....

20) Take the dog
off the horse and
put the horse
in the box

Now that we put away the horse and the plane, I think we should give the girl and boy a rest

BREAK

I hope the girl and boy had a good rest
Now, let's play some more

9. Foils: Circle
Dog, horse, box, plane, wheels

They look fine. TC is ready...

21) Get the horse out
of the box

10. Foils: Circle
Dog, horse, box, plane, boy

He looks terrific. TC is ready...

22) Take the boy and
put him on the
horse

11. Foils: Circle
Boy, girl, flag, plane, horse

I think the girl wants a ride too
Let's put her on the plane

They're having fun. TC is ready...

23) Take the flag off
the plane and put
it on the horse

Let's make a park that they can ride in
This will be the grass
Here's a little hill

12. Foils: Circle
Tree, dog, horse, plane, boy

That looks great. TC is ready...

24) Take the tree and
put it on the
hill

13. Foils: Circle
Tree, horse, plane, boy, box

That looks good. TC is ready...

25) Take the boy
off the horse

He's having fun. TC is ready...

26) Take the dog and
put him on the
hill

14. Foils: Line
Tree, horse, plane, box, boy

All right, that was great.
TC is ready.....

27) Take the boy off
the hill and put
the boy on the
horse

15) Foils: Line
Horse, plane, dog, flag, boy

That looks really great.
TC is ready.....

28) Take the girl off
the plane and put
the girl on the
horse

OK, let's give them a ride around the hill

That was wonderful. TC is ready...

29) Put the boy on
the plane

That was fun. TC is ready...

30) Get the dog and
put him on the
hill

Good work! TC is ready....

31) Put the flag on
the plane

Let's let the girl fly over the hill

She's having fun.
TC is ready......

32) Get the horse and put him on the hill

Underline denotes key elements.

Appendix C

Word Intelligibility Task

Nouns/Modifiers	Verbs/Articles Prepositions
S - blue	N - get
S - red	N - the
N - piece	N - a
S - yellow	S - put
N - white	N - on
N - boy	S - and
S - horse	N - take
S - girl	S - off
N - box	S - it
N - wheels	N - in
S - flag	S - him
N - plane	N - dog
S - tree	N - out
N - hill	S - of
N - top	S - her

S - synthetic
N - natural

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Elaine Geller

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